Standard Size, 9 x 12. AUGUST 20, 1896. Price, Six Cents.

AMERICAN MACHINIST

A PRACTICAL JOURNAL OF MACHINE CONSTRUCTION.

ISSUED WEEKLY BY THE AMERICAN MACHINIST PUB. CO.,
256 BROADWAY, NEW YORK.

VOL. 19. No. 34.

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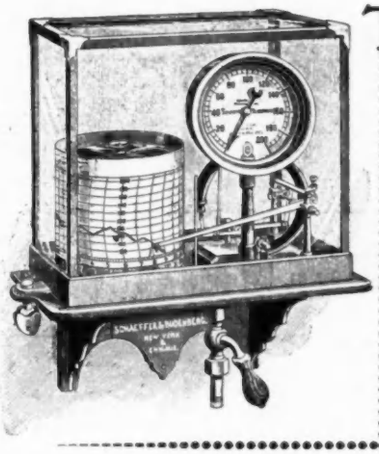

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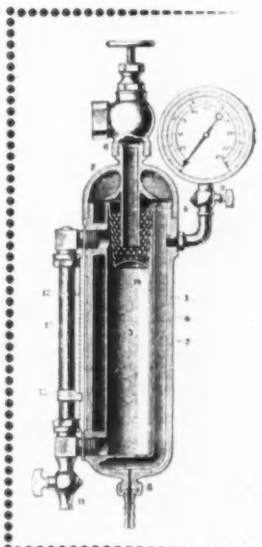

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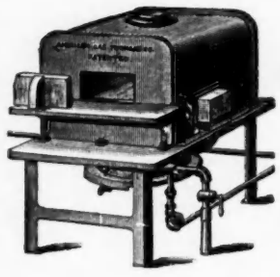

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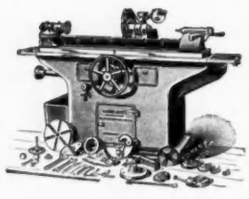

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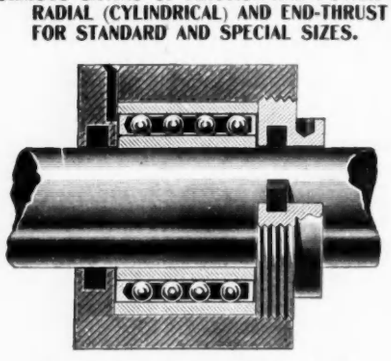

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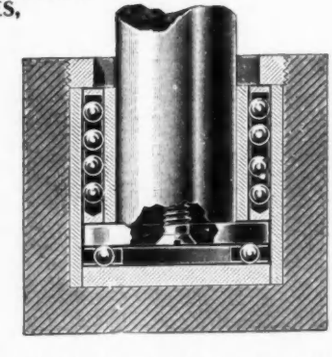

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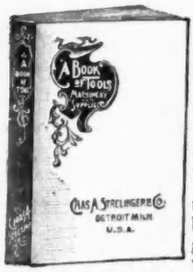

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Wilkinson & Co., A. J., Boston, Mass.

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Castings, Brass.
Lorain Foundry Co., The, Lorain, Ohio.

Castings, Iron.
Builders Iron Foundry, Providence, R. I.
Burr & Houston Co., Brooklyn, N. Y.
Leland & Faulconer Mfg. Co., Detroit, Mich.
Lorain Foundry Co., The, Lorain, Ohio.
Shriver & Co., T., New York.

Castings, Steel.
Johnson Co., The, Johnstown, Pa.

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Slocomb & Co., J. T., Providence, R. I.

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Almond, T. R., Brooklyn, N. Y.
Cushman Chuck Co., Hartford, Conn.
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Cushman Chuck Co., Hartford, Conn.
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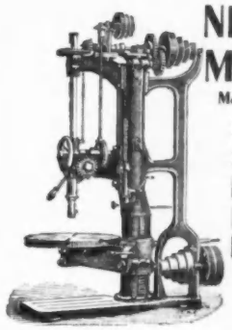
(Continued on page 12.)



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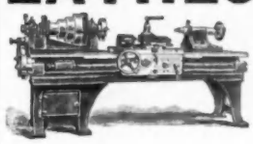
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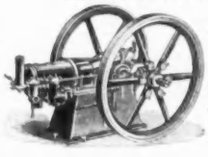
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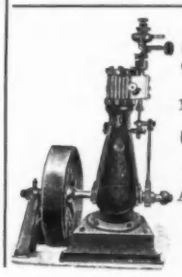
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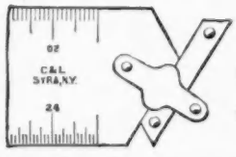

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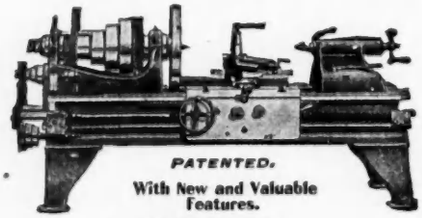

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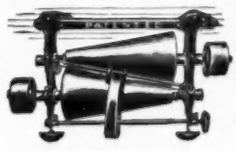

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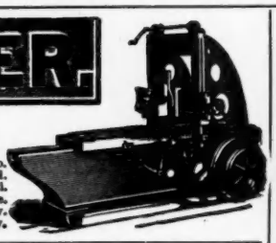

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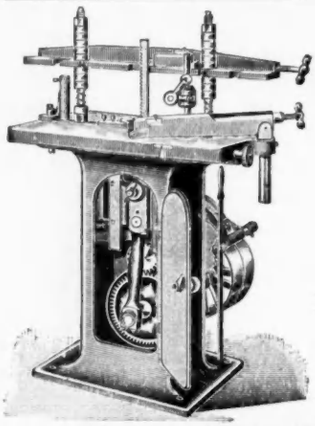

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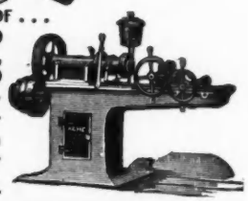

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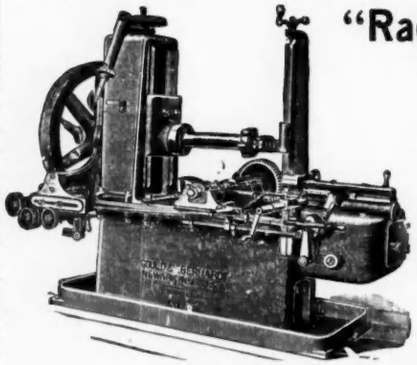

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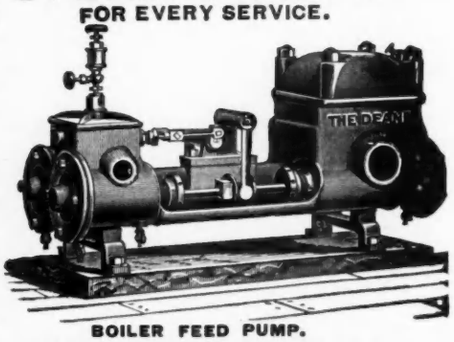

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NEW YORK, THURSDAY, AUGUST 20, 1896.

VOLUME 19. ▲ ▲ ▲ NUMBER 34.

Boring 48-Inch Fly-Wheels on a 20-Inch Lathe.

BY C. O. GRIFFIN.

Some time ago I took up the manufacture of a machine which in its largest size contained a 48-inch fly-wheel. This wheel was intended to have its rim left rough, but the hub required to be faced and bored. The largest lathe in the shop would swing but 20 inches, and as this was sufficient for all the work except the fly-wheel, a larger lathe was not to be thought of. I have a chronic objection to relying on neighbors, and consequently devised the scheme shown in the accompanying sketches.

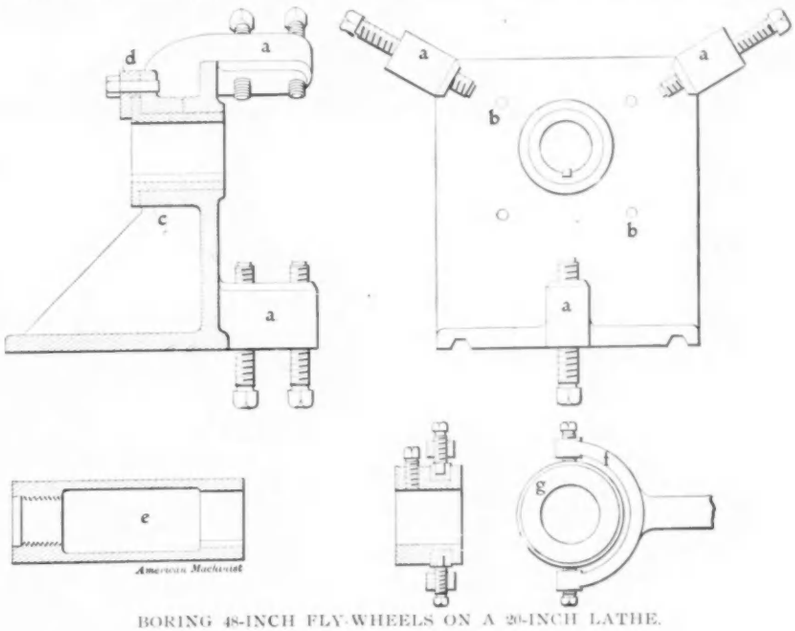
The rig consists of a suitable angle casting, properly braced, which is bolted to the tail end of the lathe bed, the tail stock being removed. The three lugs *a a a* overhang the end of the bed, and by means of the long set screws grip the hub of the wheel, which, of course, likewise overhangs the bed, where the swing available is only limited by the distance to the floor. The wheels have six arms, as all such wheels should have, and the three lugs project through the alternate arms of the wheel. Each lug having two set screws, the wheel can be readily adjusted to run true by a tram carried by the bar—the adjustment for preventing wabble being assisted by the set screws *b b b*.

The hub *c* of the fixture is bored in line with the lathe spindle, and a hardened steel bush is fitted to it, this bush having a flange at one end, which by a clip retains the bush in place. A boring bar the full length of the lathe is guided by the bush—the key in the bush engaging a keyway in the bar, thereby compelling the bush to revolve and the movement to be at the lubricated joint. The bar is driven by a long keyed sleeve *e*, screwed to the nose of the lathe spindle—a key in the sleeve driving the bar, but permitting the lengthwise feed of the bar. This feed is accomplished by a fork *f* carried in the tool post, and a ring *g* secured to the bar by a set screw.

Suitable tools in the bar bore the hole, and a compound rest from the lathe, mounted on the bar by a bracket casting, does the facing. The side of the hub selected to be faced in the fixture was the one which it was most important to have true—that is, the side next the bearing—and after the hole is bored and this side faced, the wheel is strapped down to a planer and the opposite side is planed off.

This rig did not cost as much as the sketches would indicate. I already had the bar and the hardened bush from another fixture. The compound rest was, of course, part of the lathe, and the bracket casting for clamping it to the bar had previously been made for use on the bar when used in the usual way. The only things that had to be made were the angle casting, the driving sleeve and the arrangement for the feed; so that in addition to doing a job which had been declared to be beyond the capacity of the shop, I had the further satisfaction of making use of a lot of things that had been made for other purposes before this job was thought of—and there is no keener satisfaction to the mechanic who loves his work than comes from these two very things.

The scheme has worked so well that, were a large lathe to be now available, I doubt very much if it would be used for these wheels in preference to this arrangement. With a boring mill I could hardly say as much, but that, with us, is still in the distant future.



BORING 48-INCH FLY-WHEELS ON A 20-INCH LATHE.

A Manufacturing Machine Shop—IV.

Having now described and fully illustrated the shop building, it will be found interesting to glance at some of the equipment—tools and machinery and the methods of conducting work.

In the power house are three generators; one 30, one 25 and one 6 kilowatts, each driven by a separate engine. The two little 7 x 10-inch engines shown in Fig. 16 have plain slide valves, dovetail "Atlantic" crossheads as long as the engine stroke, running in corresponding dovetail guides ½-inch longer than the engine stroke, so that the whole slide surface of both crosshead and guide is worked over equal surfaces at each stroke. These engines cost $175 each, and with 150 pounds boiler pressure either one can run or light the whole place. Of course, as they are simple slide-valve high-pressure engines, cutting off at about ⅝ or ¾-inch stroke, they are not extremely diffident in their attentions to the coal pile.

The switch board was designed with two sets of busbars, and the switches for generators and lines are all double throw, so that both generators and lines can be thrown on either set of busbars,

thus permitting any desired combination and distribution of work; for instance, all the lighting can be thrown on the top bars and have the No. 1 generator feeding into those bars; all the power cables can be thrown on the lower bars fed by No. 2 generator, or both lighting and driving can be thrown on either bar and fed by either generator. For night work, the one small (6 kilowatts) generator is sufficient to run 150 feet of shafting and the tools driven by it, and two arc lamps. North of bay No. 7 there is no line shaft at all, everything beyond bay 7 being driven by individual motors.

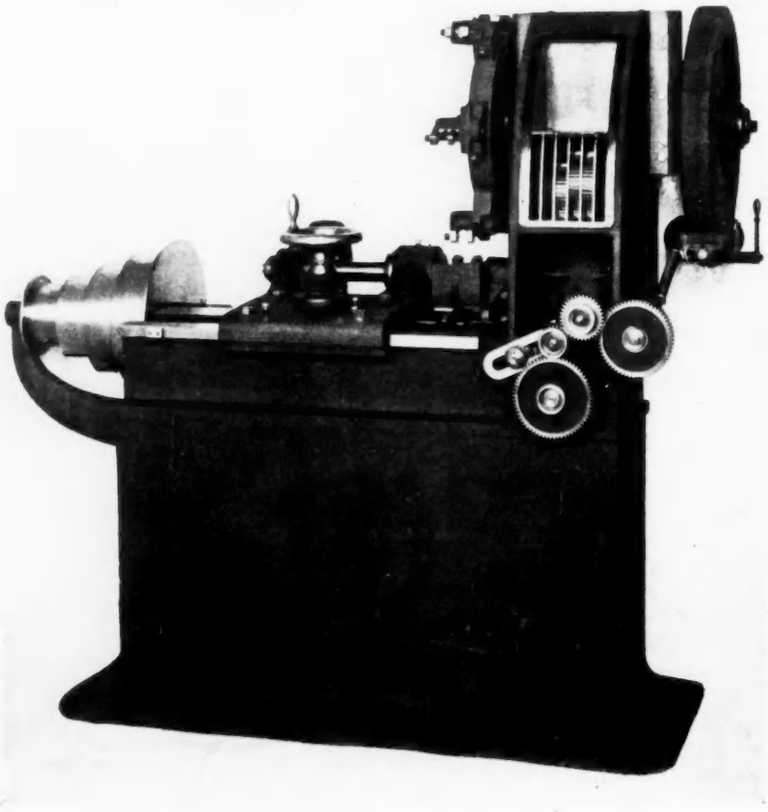
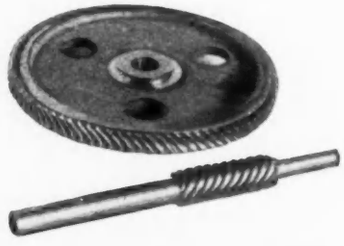


Fig. 29. WHEEL-RIM MILLING MACHINE.

All stock enters into the stores from the south, is inspected, and passes through the hands of the stock and time clerk into the shop on the north side of the stores, accompanied by a time and job check dated by an automatic dating clock to the minute the check is delivered with the stock to the workman who makes the first operation upon the piece delivered; the tools are so arranged that the work in process of finishing always travels to the north; this method makes a close subdivision of operations easy, as the job check keeps the time of each operation. All fixtures are so constructed that while the original spotting surfaces are made the basis of each fixing of the piece in the fixture, there are also fixture members which gage the last previous operation performed, so that no spoiled piece has any further work done on it; the full count of the job, wasters and all, is signed for by the inspector whose piece-number stamp on a piece is his certificate of perfection; the inspector notes the number of perfect pieces which he turns over to the finished stores clerk on the job ticket, and also notes the pieces, if any, spoiled by each workman through whose hands the job has passed.

It will be observed that, even if the men were disposed to give incorrect time, the clock-time stamp on the job ticket would make this impossible; that the job check, or ticket, fixes the pay-roll time, and that footings of the piece cost, job cost and time-book hours must always agree, so that no question can possibly arise as to what has occurred, and the responsibility for any spoiled work is fixed beyond dispute by the inspector's check. The percentage of spoiled work is extremely small, as might be expected; no piece properly seated in the fixture can come wrong, since the cutting tools, except in the grinding room, are not adjustable by the workmen save in case of renewal of edge, and the setting of a cut to gage is always under skilled supervision.



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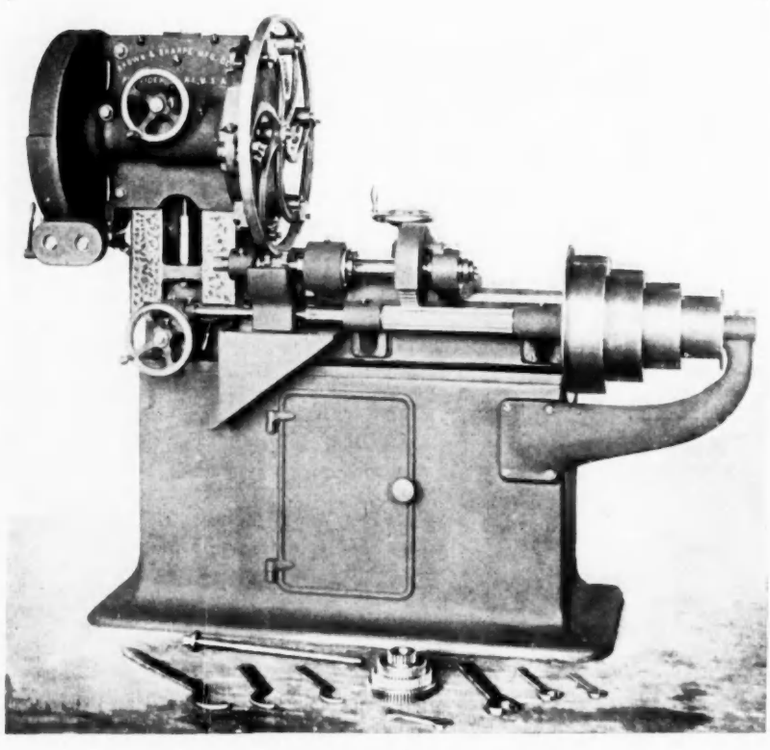

Fig. 30. WHEEL-RIM MILLING MACHINE.

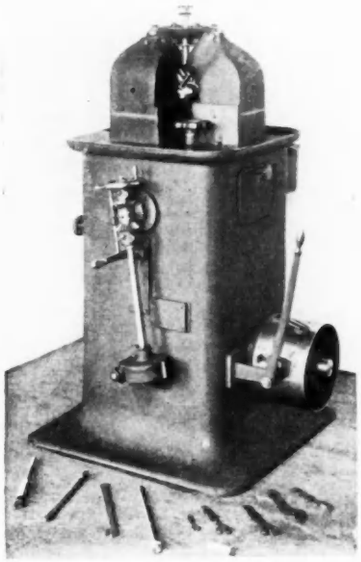

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Fig. 26 shows this spiral pinion and the gear which drives it. The driving gear is of brass, has 81 teeth, and can be cut at the rate of 60 finished gears per hour, or 600 per day, on the specially designed machine shown in Figs. 27 and 28. This worm gear is about 6 inches diameter and has been cut in forty-seven seconds. As the wheel is brass, the cutter can have a very high speed; the hob is, of course, geared to the worm-wheel spindle and is journaled in a swinging frame which lifts to the wheel by a cam motion as the cut proceeds. This is a very simple, elegant and effective machine; it is speeded to cut a wheel in something less than two minutes, as the production demanded is fully supplied at that rate. The machine has an automatic knock-off, and all the chips fall into the box in front. The engravings give a very clear idea of this excellent example of the special tool building.

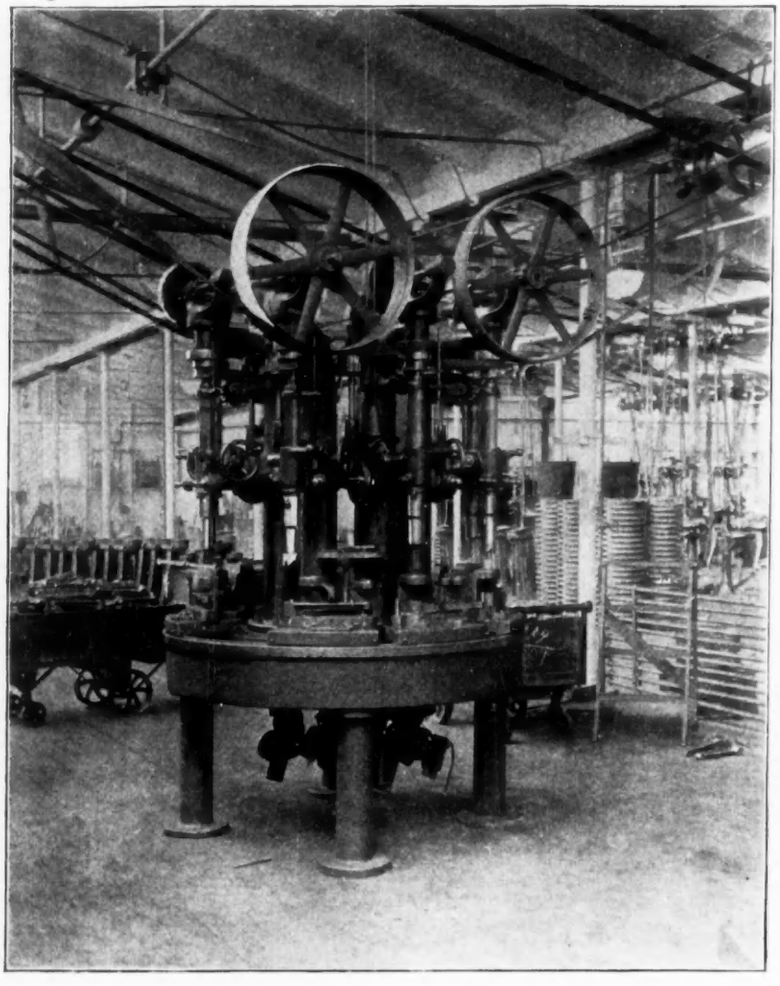

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Fig. 31 gives a general view of the gear-cutting room, which employs one man only to attend all of its machines. The gears produced are shown in the foreground; the four gear cutters on the left for plain spur gears are Brown & Sharpe's automatics, and cut eight teeth at once on the large gears. The line shaft is driven by an independent motor, as shown, and the machinery of this room is so efficient and so nearly automatic that one man can easily keep all the tools full of work, and can turn out the gearing for fifty machines (various sizes) per day. The worm wheels, before mentioned, have 81 teeth, diameter of wheel about 6 inches, and the large spur gears have 320 teeth; it is to be understood that only the lathe work on the small spiral gears and the chucking on the other gears is done before the parts go to the gear room. It is to be doubted if similar work is made elsewhere so cheaply as in this room.

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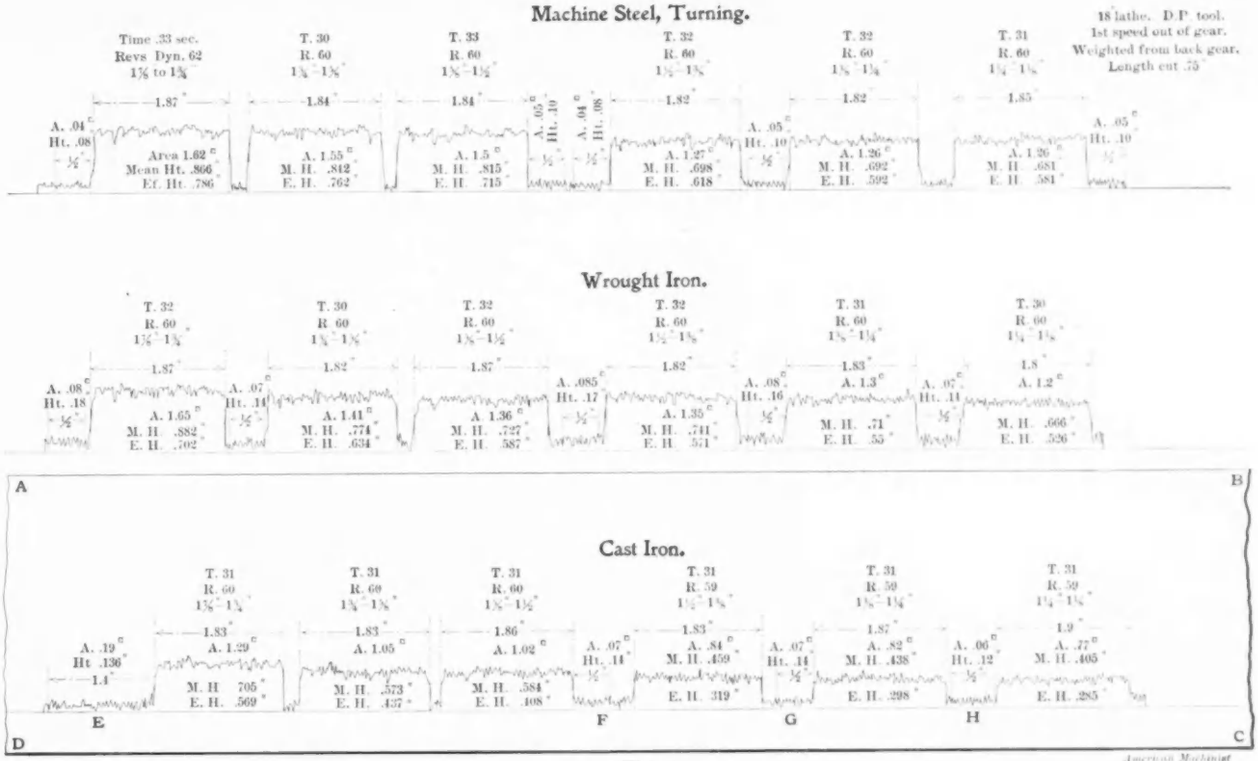

Fig. 5

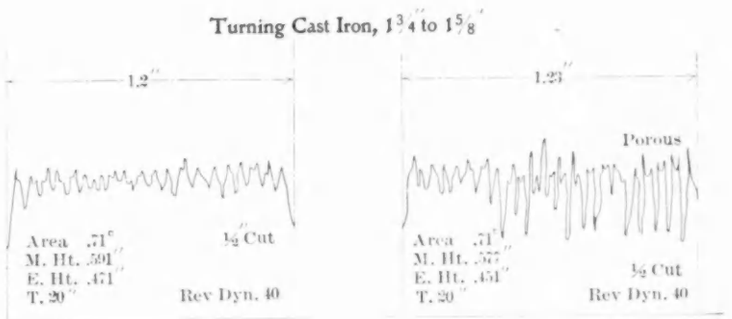

Fig. 6

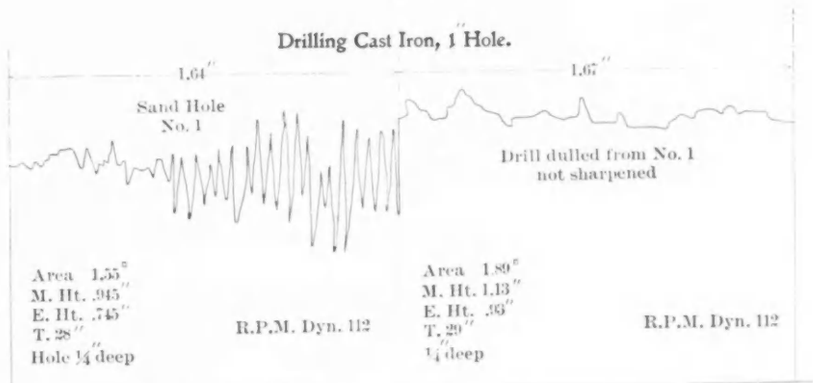

Fig. 7

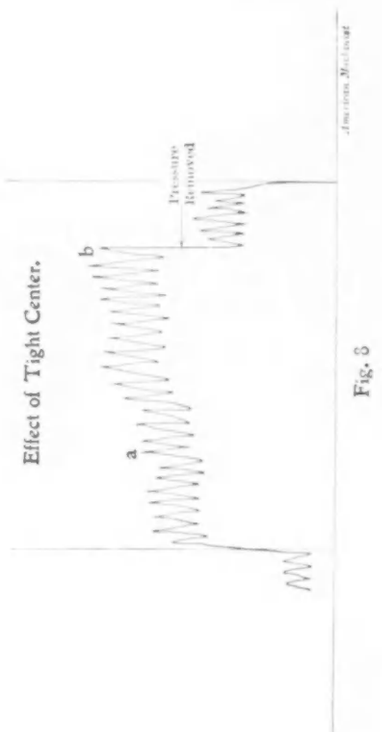

Fig. 8

READINGS FROM HYDRAULIC DYNAMOMETER.

thus permitting any desired combination and distribution of work; for instance, all the lighting can be thrown on the top bars and have the No. 1 generator feeding into those bars; all the power cables can be thrown on the lower bars fed by No. 2 generator, or both lighting and driving can be thrown on either bar and fed by either generator. For night work, the one small (6 kilowatts) generator is sufficient to run 150 feet of shafting and the tools driven by it, and two arc lamps. North of bay No. 7 there is no line shaft at all, everything beyond bay 7 being driven by individual motors.

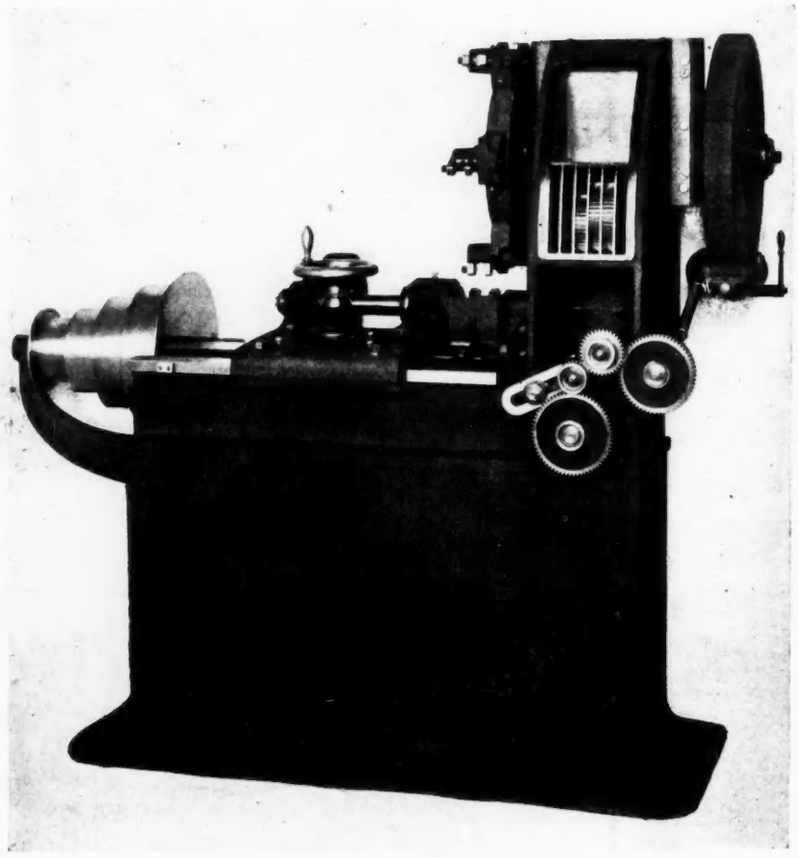

Fig. 29. WHEEL-RIM MILLING MACHINE.

All stock enters into the stores from the south, is inspected, and passes through the hands of the stock and time clerk into the shop on the north side of the stores, accompanied by a time and job check dated by an automatic dating clock to the minute the check is delivered with the stock to the workman who makes the first operation upon the piece delivered; the tools are so arranged that the work in process of finishing always travels to the north; this method makes a close subdivision of operations easy, as the job check keeps the time of each operation. All fixtures are so constructed that while the original spotting surfaces are made the basis of each fixing of the piece in the fixture, there are also fixture members which gage the last previous operation performed, so that no spoiled piece has any further work done on it; the full count of the job, wasters and all, is signed for by the inspector whose piece-number stamp on a piece is his certificate of perfection; the inspector notes the number of perfect pieces which he turns over to the finished stores clerk on the job ticket, and also notes the pieces, if any, spoiled by each workman through whose hands the job has passed.

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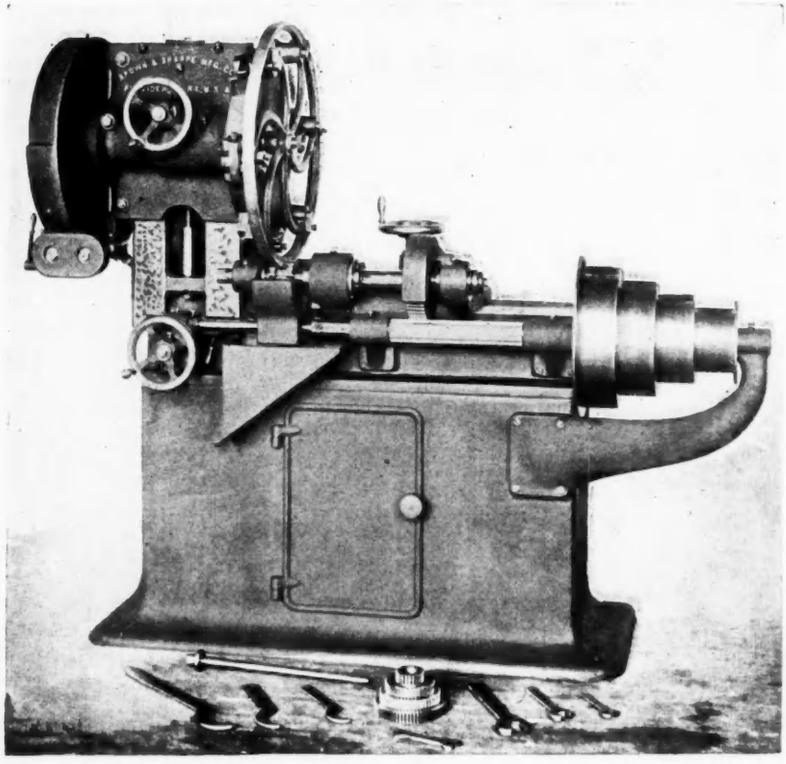

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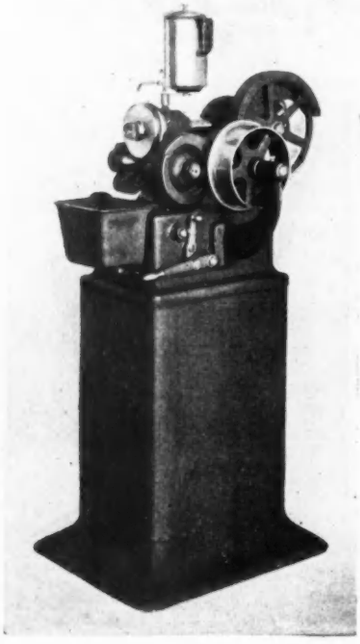

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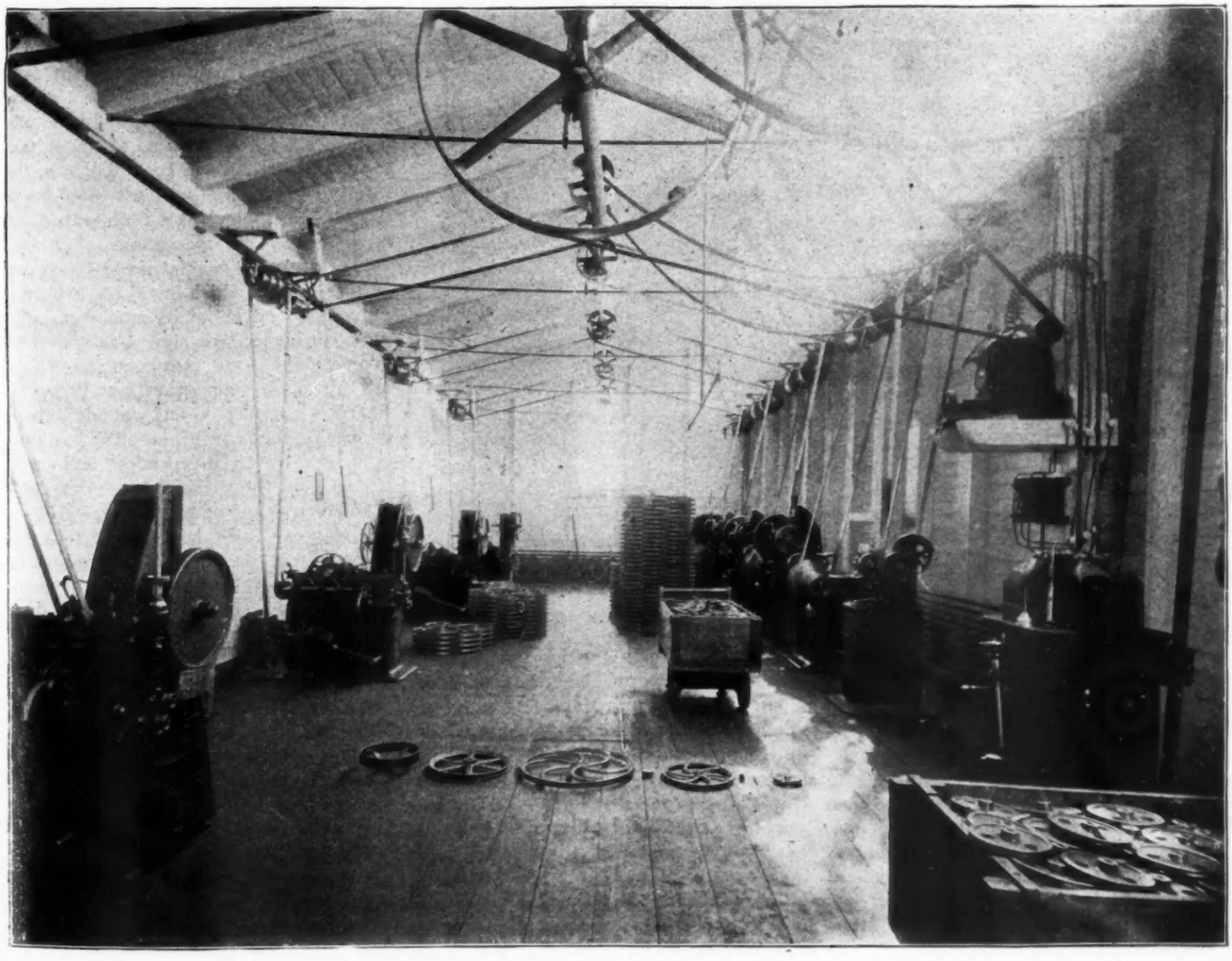

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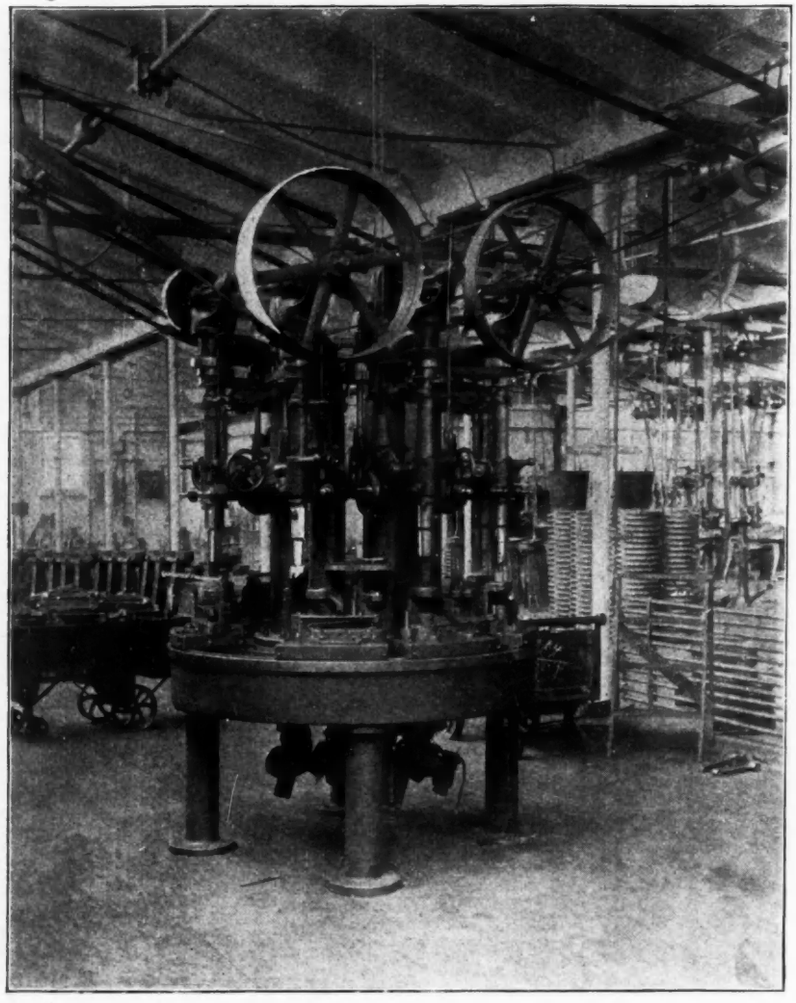

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pared with the best gang drills used to do the same jobs. This tool was built by Gould & Eberhardt from a special design; the eight spindles and their goose neck uprights, automatic feeds, knock-offs, etc., are all regular Gould & Eberhardt driller parts, fitted to a circular stationary base carried on four pillars. The fixtures are each carried on four small wheels carefully fitted to the circular railway; the spindles are driven at differing speeds, to suit different diameters of cuts. In operation, the workman begins by filling all the traveling fixtures with previously "spotted" work; that is, pieces which have their points of support in all the similar fixtures fit to go in the fixtures when they come to the machine. Next he pushes a fixture under a first operation spindle, and starts the feed on that cut; he then walks on to the next spindle and starts it to work, and thus continues to walk round and round the machine, with the final result after the cycle of work is once completed and all the spindles are simultaneously in operation of finishing, and taking out a finished piece and putting in a new piece each time he encircles this "merry-go-round," as the hands have aptly named the unique machine.

A somewhat similar machine was used by the Douglass Pump Co., Middletown, Conn., many years ago, and is still in use there, I presume, for boring pump barrels. In the Middletown machine, however, the fixtures were all secured to a revolving part of the machine; the effect was nearly the same, the workman taking out and putting in a new piece of work for every step the fixture carrier took in partial circuit under the spindles, which were all automatically withdrawn upon the completion of their down stroke. The circular railway and loose-wheeled fixtures make quite another structure, however, with important advantages in the way of individualized spindle action.

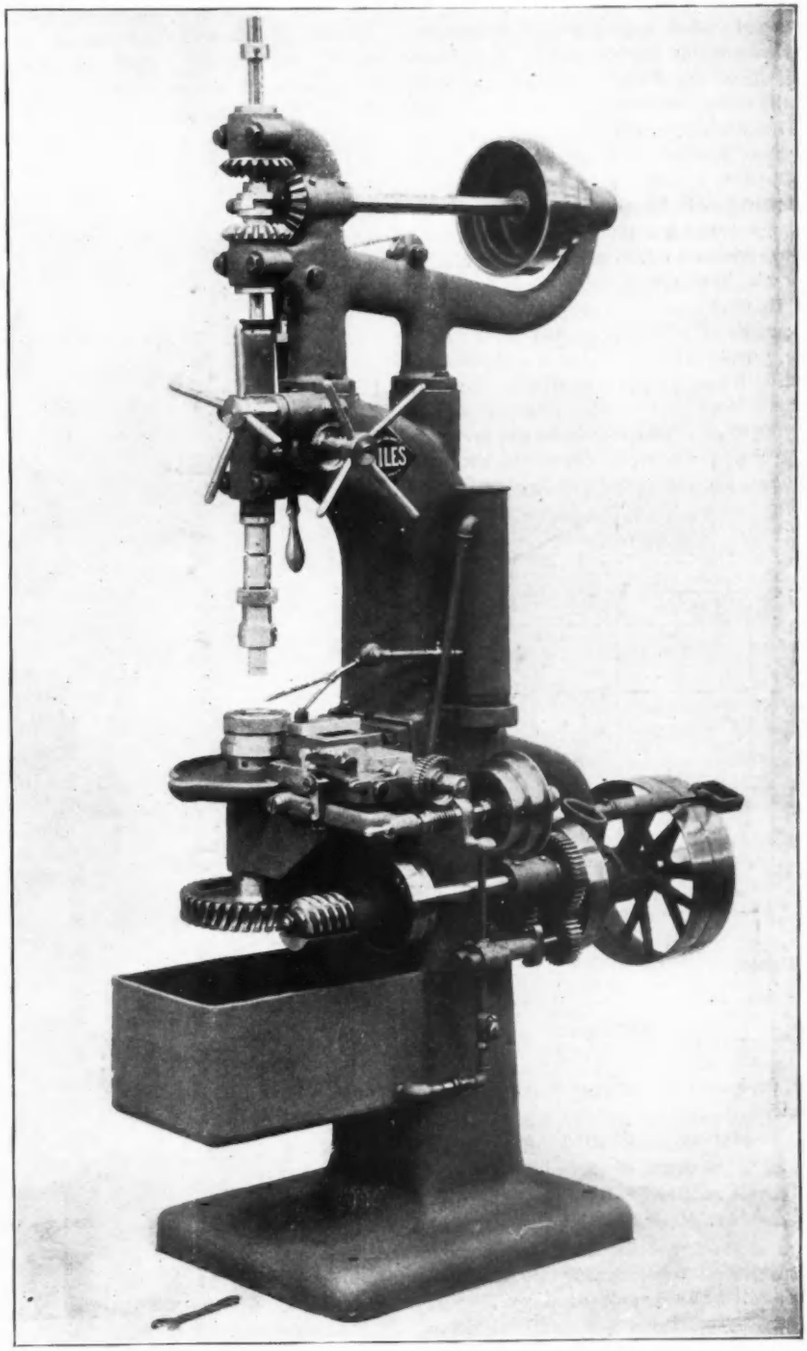
This machine is especially adapted to finishing short arms or levers having holes and hubs differing from each other at the two ends, and can save easily 90 per cent. of the labor cost on such parts as commonly finished in good shops. It is capable of general application and modification to suit pieces of almost any conceivable finish, and each piece produced by the aid of the "merry-go-round" is finished at one setting in the fixture, and hence is true with itself.

▲ ▲ ▲

Some new express passenger locomotives recently completed for the Great Eastern Railway of Great Britain, are fitted with full-fledged cabs with which not even an American engineer could find fault. The peculiar argument that has kept cabs off of English locomotives so long—that the men would not be so attentive to their duties if made comfortable—is one of the strangest perversions of common sense that we are acquainted with.

Drilling, Tapping and Forming Machine.

This machine, which was especially designed for finishing bicycle sprocket wheels, is adapted for chucking, counterboring, tapping or facing the hubs of such work, while at the same time the rim is being turned or specially formed.



DRILLING, TAPPING AND FORMING MACHINE.

The spindle, which is driven by a three-step cone for 1½-inch belt, has reversing gears and clutch motion for running in either direction. It has wheel feed with an eccentric sleeve for throwing out the worm when tapping, and quick-return motion. The spindle carries a forked collet on which is pivoted a double drill or tap socket; this is held truly central by a sliding ring which fits over the socket. A drill and facing tool can be held in one end and a tap or counterbore in the other, and either end may be quickly brought into position. The spindle has also a stop collar for working to exact depth.

On the front of the column is mounted a knee which carries a slow motion spindle in exact alignment with the drill spindle. The top of this spindle has a work holder, and it is driven at a constant velocity suitable for milling or turning this class of work. On the top of the knee is

mounted a slide which has a form tool suited to the work in hand, and which is operated by a feed screw driven by worm and gear, three changes of feed being provided. The worm is of the drop-box style, with adjustable knock-off motion.

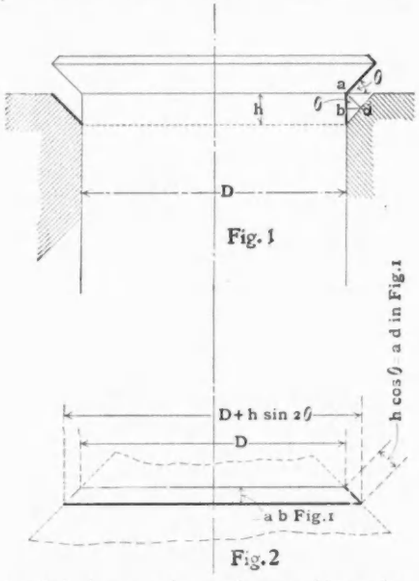
An oil pump and tank are mounted on the column, with a supply pipe leading to the work; while a pan is cast around the work-table for catching oil and chips, and which has a drain pipe leading back to the tank.

The machine is made by the Niles Tool Works, Hamilton, O.

▲ ▲ ▲

Opening of Conical-Seated Valves.

A point which I have never seen given anywhere, and which may prove useful to any who have not troubled to look into it for themselves, is an expression for the waterway of a conical-seated valve; as a rule, people make a shot at it and are content with rough approximations. Unwin, in his "Machine Design," gives the waterway as $\pi D h$, which may be anything up to 80 or 90 per cent. in excess of the true amount. If this were followed, it might



land designers of pumping machinery into a hole.

In accompanying diagrammatic sketch

D = diam. of valve;
h = lift of valve;
θ = angle of valve seat.

Diam. $a\,d$ normal to valve seating, and $b\,d$ normal to axis of valve: The area of waterway is the surface of a conical frustum whose slant side is $a\,d$ and whose diameters are D and $D + 2\,b\,d$. (Figs. 1 and 2.)

$a\,d = h \cos.\ \theta$;

$b\,d = a\,d \sin.\theta = h \sin.\theta \cos.\theta = \frac{h}{2} \sin.\ 2\,\theta$.

The required area is the surface of that portion of the cone shown bounded by heavy lines in Fig. 2

$$\text{and} = \pi \left\{ D + (D + h \sin.\ 2\,\theta) \right\} \frac{h}{2} \cos.\ \theta;$$

$$= \pi\, h \cos.\ \theta \left\{ D + \frac{h}{2} \sin.\ 2\,\theta \right\}$$

Value of cos. θ and sin. 2 θ, can be taken as required out of a book of tables or pocket book. For convenience of reference we may give them here for, say, 30, 45 and 60 degrees; 45 degrees is a usual angle.

θ.	Cos. θ.	Sin. 2 θ.
30°	.866	.866
45°	.707	1.000
60°	.500	.866

Taking a case, in round numbers:

Diam. = 2 inches;
Lift = ¼ inch;
θ = 45 degrees;

Area of passage = 3.1416 × ¼ × cos. 45° (2 + ⅛ sin. 90°) = 1.18 square inches:

The value $\pi D h$, usually taken (circumference of valve × lift), gives 1.57 square inches, 33 per cent. too much. This discrepancy increases as inclination of valve seat gets steeper. When $\theta = 60°$, $\pi D h$ would be nearly 90 per cent. in excess.

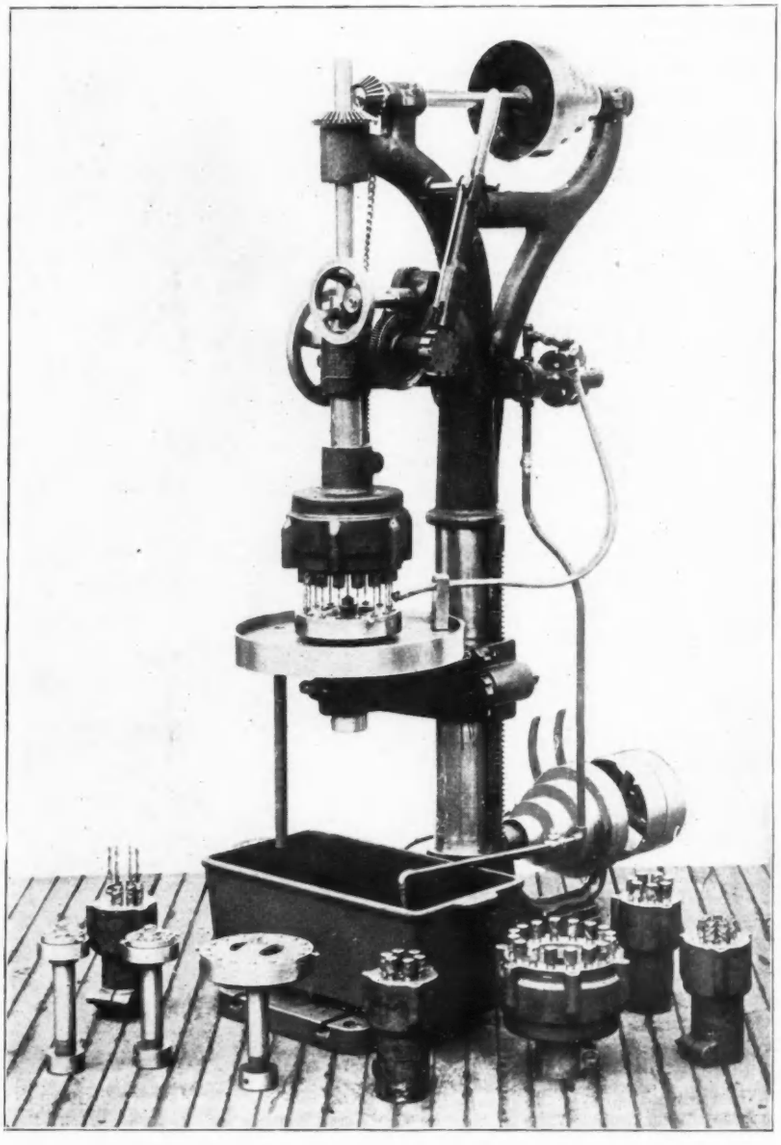
Hartford, Conn. H. ROLFE.

▲ ▲ ▲

Multiple-Drilling Attachments to Drill Press.

We give on this page a perspective view of a drill press adapted to drill a number of small holes simultaneously, and also detail drawing showing the construction of the attachment for doing the work.

As will be perceived, various heads are



MULTIPLE-DRILLING ATTACHMENTS TO DRILL PRESS.

furnished according to the number of holes to be drilled, and a number of small spindles drilling through jig bushings in a special work holder insure accurate spacing The supplementary spindles are driven by means of small spur gear wheels, as shown, and a pump supplies lubricant in abundance.

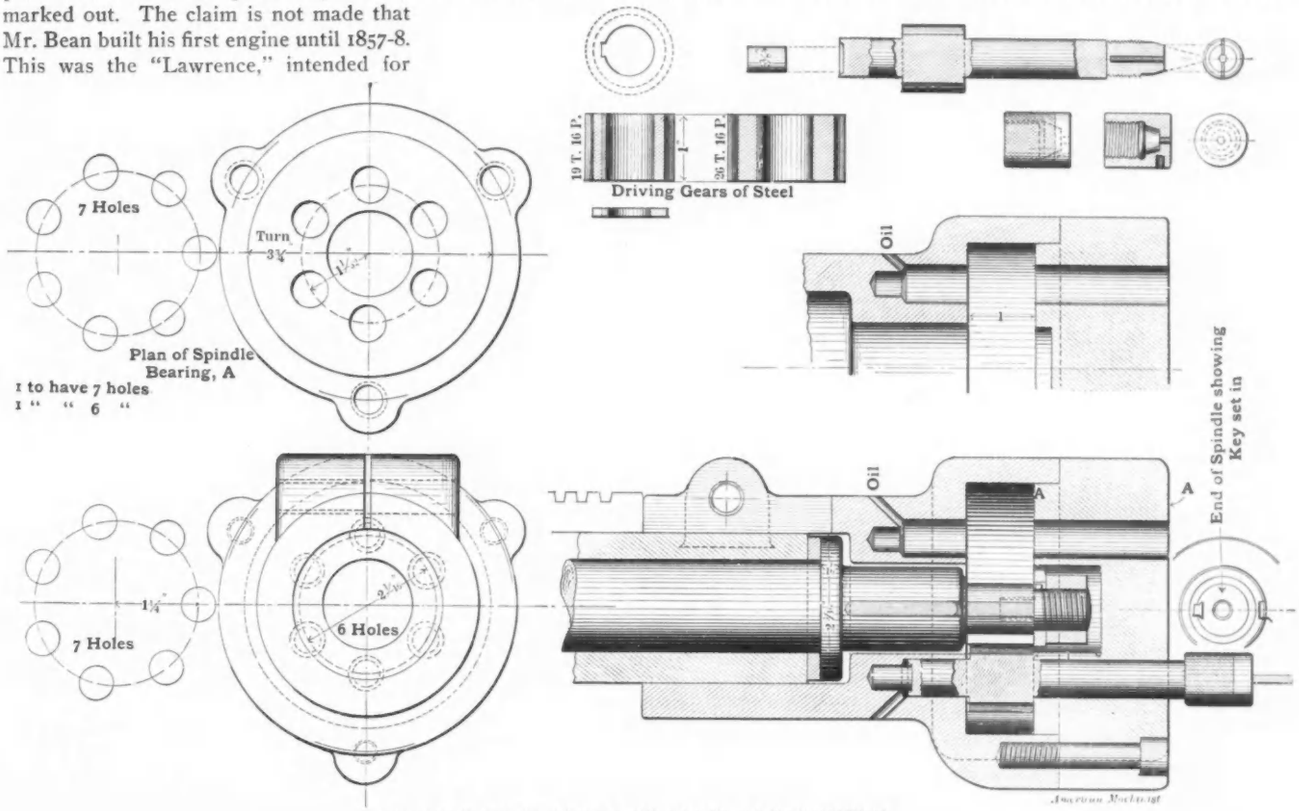
The machine is made by the Davis & Egan Co., Cincinnati, O.

Death of an Improver of the Steam Fire Engine.

The announcement of the death of Nehemiah S. Bean, the venerable manufacturer, of Manchester, N. H., is coupled in most of the press notices with a statement that he constructed the first steam fire engine. Probably no man had been more honorably or more prominently associated with the manufacture of steam fire engines than the late Mr. Bean. He was master of his business, and strict integrity was a distinguishing characteristic. It might have been said, no doubt, that when he built his first engine it was the best that had been constructed. But it was not the first by a number of years. He simply took an advanced step along a path that had been previously clearly marked out. The claim is not made that Mr. Bean built his first engine until 1857-8. This was the "Lawrence," intended for the city of Boston. But Boston already had a steam fire engine before that time, called the "Miles Greenwood," built by a chief engineer of Cincinnati of that name. She was put in service in the city of Cincinnati as much as five years before the "Lawrence" was built, and purchased later by Boston.

Nearly contemporary with the "Miles Greenwood" were the "Young Merchant," of Philadelphia, and the "Young America," of New York, the latter built by a man named Ericsson, probably the John Ericsson of monitor fame, for as far back as 1840 he was awarded the Mechanics' Institute Medal in New York for his model of a steam fire engine. About 1852, Cataract Company, No. 4, of Boston, visited Philadelphia and were permitted to amuse themselves with the working of the "Young Merchant." James Young, of this city, who is still living, was the engineer.

The construction of steam fire engines, therefore, was almost an established industry when Mr. Bean took hold of it. But his service was none the less valuable. He made improvements in boilers and gave a more practical character to the machine generally. The third steam fire engine to come to Boston was Engine No. 1, also of Mr. Bean's manufacture. When he engaged in the business the days of the old manual engine in large cities were numbered. The contest between steamers and hand tubs in some places was protracted and bitter, occasionally almost breeding riot. But the old firemen of Boston submitted gracefully. Their practical judgment was appealed to without assailing their prejudices, and they were too intelligent to oppose the inevitable. The first crane-neck engine in Boston was built at Mr. Bean's works, according to instructions given by Chief Damrell. Mr. Bean lived in a time when almost all the great improvements in fire service were made, and hardly any one contributed more generously to them than he.—"Boston Transcript."



DETAILS OF MULTIPLE DRILLING ATTACHMENT.

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It is announced that the Winchester Repeating Arms Co., and perhaps others, who were defeated by the Savage Repeating Arms Co. before the Board of Commissioners for the State of New York appointed to select an arm for the State troops, will contest the award, and will endeavor to prevent the Governor from approving the report of the commission. It is also stated that whether the Governor approves the report or not, the matter will be taken into the Legislature for investigation of charges made to the effect that at least two members of the commission were biased by more or less intimate connection with men interested in the Savage arm. It is quite the custom for such protests to be made in every case of an award of this kind, and it seems to be thought necessary by those who are defeated in such contests to be able to give some colorable reasons for their failure to secure contracts. We think instances are very rare in which such an award has been made without subsequent efforts to have the report of the commission set aside. We do not know whether or not the contestants have grounds for charges against this commission or not, but the reasons given seem to be rather diaphanous—such, for instance, as that Mr. Bliss was a friend of Mr. Abell, who acted as secretary of the commission and who introduced the bill; that Mr. Risley, of Utica, N. Y., worked for Mr. Bliss at one time in Brooklyn, Mr. Risley having had something to do with the patents on the Savage gun; and that Mr. Shaw, of Watertown, another member of the commission, is a friend of Richard Marcy, who was a partner in the coal business of Mr. Hackett, Mr. Hackett having some connection, we do not know just what, with the Savage gun. These reasons, it will readily be seen, are hardly sufficient to cause such men to stultify themselves by the selection of an arm believed by them to be inferior to others exhibited.

A Hydraulic Dynamometer.*

BY JAMES D. HOFFMAN, LAFAYETTE, IND.

This machine, constructed at Purdue University in the winter of 1894-95, has been in use since September, 1895.

Two cylinders, *E E'* (Fig. 2), are fastened diametrically opposite each other to a double yoke, which in turn is fastened to a hollow shaft. Each cylinder is connected to the center of the shaft by the hollow tubing and ground joint shown at *a'*. The cylinders are rotated; that is, the shaft is rotated by the pull of the driving belt on the loose pulley *A*, tending to force the brass pistons to the bottom of

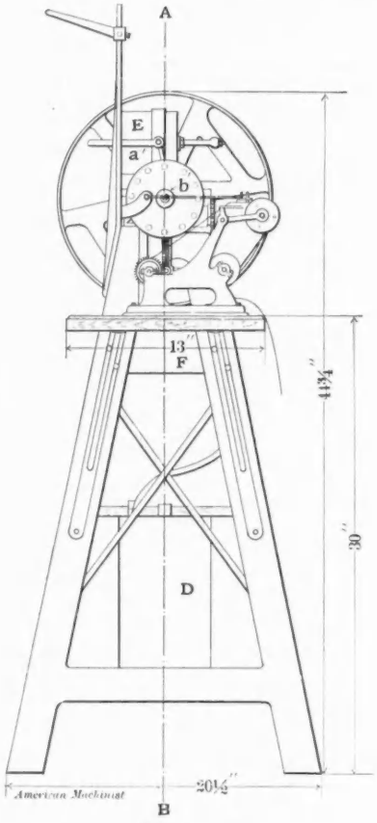

Fig. 1

the cylinders. The shaft and cylinders are full of oil, and any fluctuations of power between *A*, the receiving and *C*, the delivering, pulleys, are shown in pounds on the gage to the right, and an indicator card on the left hand. The oil flows around the bearing *G*, giving good lubrication, and is kept from leakage by means of the stuffing box shown in the section (Fig. 3).

By a number of interchangeable gears, the paper has different speeds, which is of much importance in taking cards where sudden changes of resistance appear.

In working up the cards, the area and length are measured accurately, and the mean height (M. H.) obtained. This M. H. is converted into M. P. by calibrating the machine and finding the value of the resisting spring under the casting *b'* (Fig. 2).

*Abstract of a paper presented at the St. Louis meeting (May, 1896) of the American Society of Mechanical Engineers.

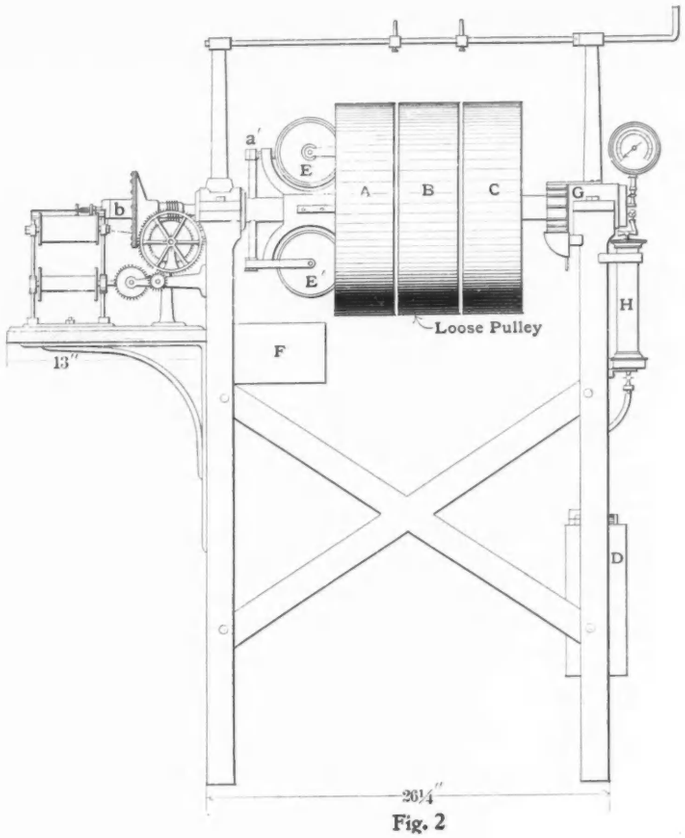

Fig. 2

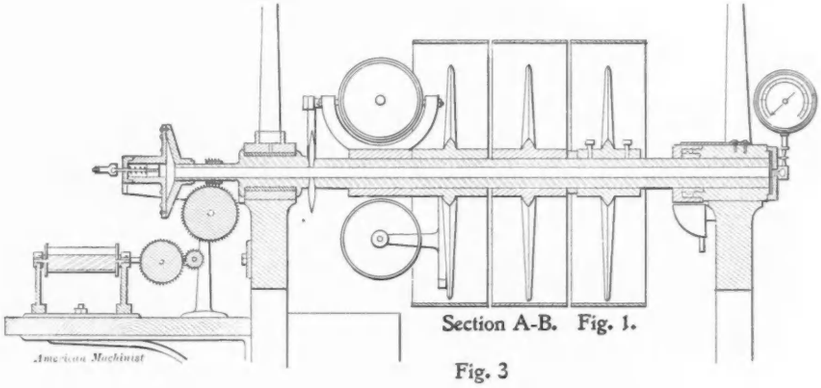

Fig. 3

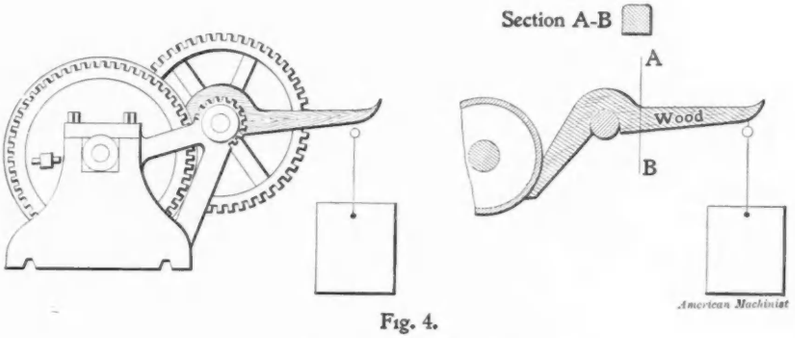

Fig. 4.

BRAKE TO INCREASE RESISTANCE.

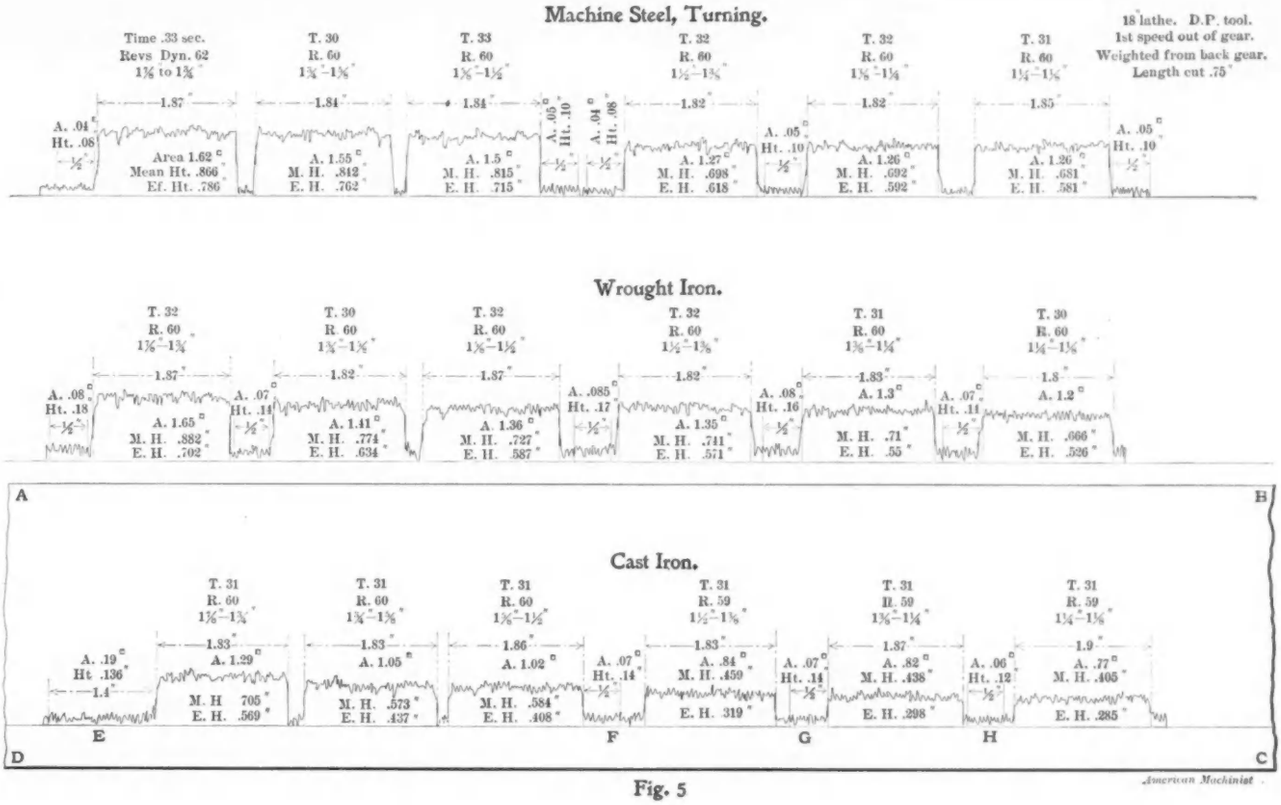

Fig. 5

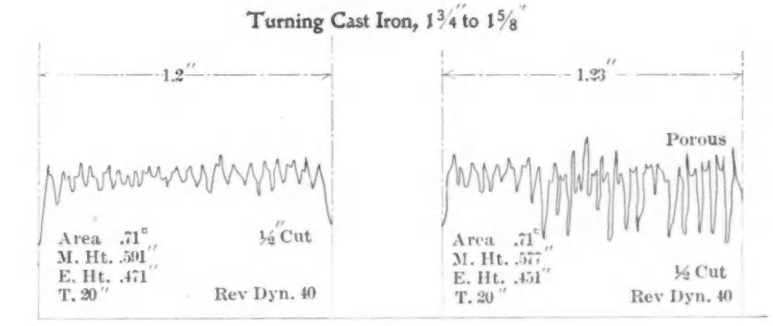

Fig. 6

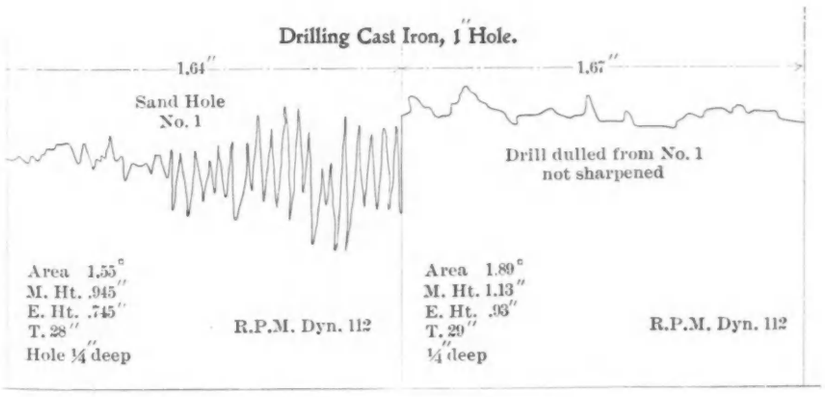

Fig. 7

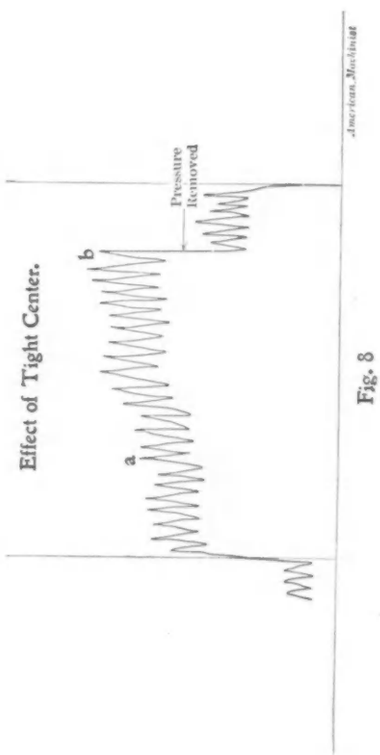

Fig. 8

READINGS FROM HYDRAULIC DYNAMOMETER.

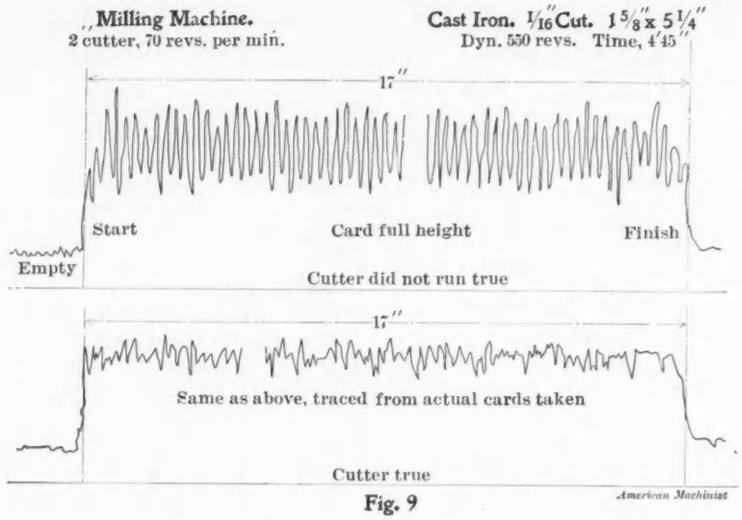

Fig. 9

readily determined when the scale of the spring is known.

In its use the dynamometer has possibly been more accurate when operated by differences; that is, take a card of the machine (lathe or planer) in motion without cutting; then a card following, with the tool in operation. The differences in the hights of the cards are evidently due to the action of the tool. If the friction of the machine and work (without cutting action) is not sufficient to move the pencil from the base line, under the compression of the spring used, a device shown in Fig. 6 is employed. With slight modifications this has been applied to every machine tested. If the object of the test were to register the *friction* of the machine, then the appliance shown in Fig. 6 would be omitted, and the compression on the spring reduced by unscrewing the cap on the casting *b'*.

A few of the cards have been added to show how readily the recording device responds to any slight change in the power transmitted.

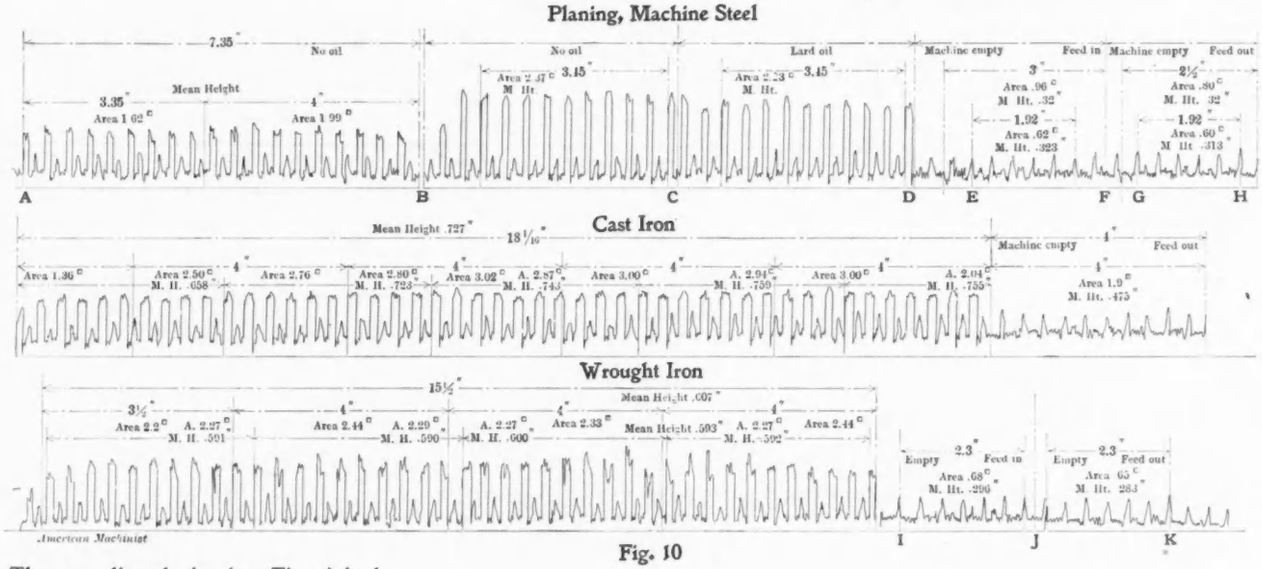

Fig. 10

The recording device (see Fig. 4) is designed to give a straight line motion at the end of the pencil arm. A bronze point and metallic-surfaced paper are used. No flexible material, such as cup leather, is used in the cylinders, and the pistons fit loosely enough to reduce the friction to a minimum. When the oil runs low by leakage, it is the work of but a few minutes to replenish, by means of the pump at the rear. The leakage does not exceed a half pint daily when doing ordinary duty.

When in use, the cylinders are surrounded by a sheet-iron case to catch the oil. *D* and *F* are oil tanks.

To insure the pencil returning each time to the same line when the load is removed, a constant pressure is put on the spring when the piston in *b'* (Fig. 2) is against the stop. A stationary bronze point is set to record this line, and all measurements are taken from it. The zero line is below the base line, a distance

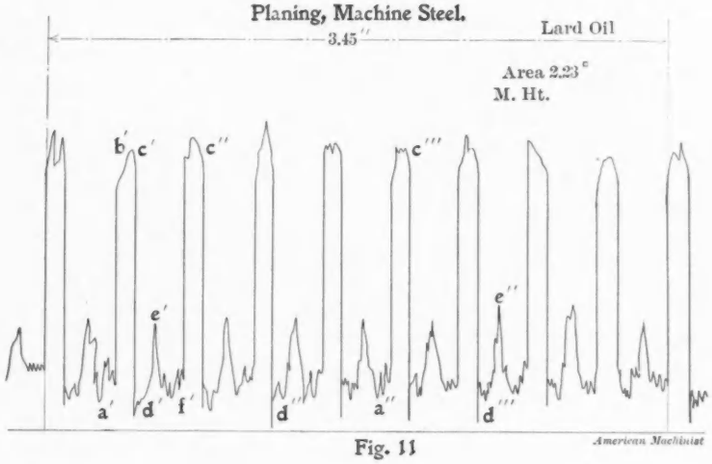

Fig. 11

Fig. 7 is taken from a 12 x 18 tracing, and serves to show the gradual reduction in hight of the card as the diameter of the stock decreases; also, to compare the relative hights of cards for different metals.

The card as it comes from the dynamometer is four inches wide, shown at *A, B, C, D.*

The friction of the machine and work was such a variable quantity, especially so considering the pressure on the tail center, that it was found necessary to take friction cards at intervals during the series, as *E, F, G, H.*

Figs. 8 and 9 show the effect of sand holes in a casting. The cutting edge of the drill (Fig. 9) was dulled, as indicated by the increased hight of the card after passing the sand hole.

Fig. 10 was taken while turning machine steel. The tail center proved to be too light, and from *a* to *b* shows an increase, due to the grooving of the center. At *b* the pressure was removed.

Fig. 11 shows a cut taken on the milling machine. The upper card shows the effect of running with the cutter out of center. The lower shows the same work done with a true cutter.

Fig. 12 is taken from a 12 x 24 tracing, and illustrates the action on a shaping machine. The change shown between the cards marked *A B* and *B C* is due to increasing the feed. That shown between *B C* and *C D* is due to cutting with and without lard oil, while the difference between *E F* and *G H* was that of the machine running empty, with and without the feed. *I J* and *J K* show similar reductions.

Fig. 13 is a part of Fig. 12 shown full size. The tool strikes the work at *a'* and the pencil responds to *b'*; from *b'* to *c'* is the length of the card during cutting action. The tool leaves the work at *c'*, and the pencil drops to *d'*. The machine then reverses, and the pencil mounts gradually to *e'* at about the middle of the return stroke, and then down to *f'*, where the next forward movement begins. As the tool is released at *c' c'' c'''* there is apparently a reaction which carries the pencil below the normal condition, shown at *d' d'' d'''*, etc.

It will be noticed from these cards (Fig. 12) that even the power required to drive the feed mechanism can be readily determined. In working up the cards from a shaper, it is found best to take areas from similar points; that is, from point *a'* to *a''*, or *e'* to *e''*, etc.

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This issue of the "American Machinist" has been prepared in the midst of what has been the most severe and trying conditions of weather experienced in the city since reliable records of weather began to be kept. High temperature and an evaporation-preventing humidity have combined forces, and the list of fatalities is an appalling one. We hope climatic conditions will be improved before this number reaches our readers.

Flow of Compressed Air in Pipes.

BY WM. COX.

Much has been published lately in the columns of the "American Machinist" on the subject of compressed air and its application to practical purposes. I have been brought into contact recently with some very widely differing cases involving the flow of compressed air in pipes, a tolerably certain solution of which is generally necessary in order to make a successful installation.

When working out in this connection my universal fluid flow computer, I was led to a closer examination of Darcy's formula for the flow of water in pipes, which, when modified, so as to make it applicable to *any* other fluid, is

$$Q = c\sqrt{\frac{d^5 \times (p_1 - p_2)}{w \times l}}$$ where

Q = discharge in cubic feet per minute;

d = diameter of pipe in inches;

p_1 = initial pressure in pounds per square inch;

p_2 = final pressure in pounds per square inch;

$p_1 - p_2$ = difference of pressures or pressure required to overcome friction and produce the velocity of flow;

w = density or weight in pounds per cubic foot of the fluid at initial pressure p_1;

l = length of the pipe in feet;

c = a co-efficient varying with the diameter of the pipe.

A close examination of this formula brings out some points which seem to favor its application to the flow of compressed air in preference to some others used for this purpose. Before going into these in detail I give here the density of air at different pressures, so as to simplify the understanding of what follows, thus:

Air at atmospheric pressure,		$w = 0.0761$ lbs.
" 15 lbs. gage	"	$w = 0.1522$ "
" 30 " "	"	$w = 0.2283$ "
" 45 " "	"	$w = 0.3044$ "
" 60 " "	"	$w = 0.3805$ "
" 75 " "	"	$w = 0.4566$ "

If we now put the formula into the form

$$\text{Discharge} = \frac{1}{\sqrt{w}} \times \sqrt{\frac{c^2 \times d^5 \times (p_1 - p_2)}{l}}$$

and assume that the second factor on the right hand side of the equation is constant, then we see that the discharge will vary inversely as the square root of the initial density of the compressed air, which density depends upon the initial pressure. We have for different pressures the following values:

Pressure	15 lbs.	30 lbs.	45 lbs.	60 lbs.	75 lbs.
$\sqrt{w} =$	0.39	0.48	0.55	0.62	0.68
$\frac{1}{\sqrt{w}} =$	2.56	2.08	1.82	1.61	1.47

Supposing, in a given compressed air pipe system, that $p_1 - p_2 = 15$ pounds and that the factor

$$\sqrt{\frac{c^2 \times d^5 \times (p_1 - p_2)}{l}}$$

is equal to, say, 100, then the discharges of free and compressed air will be as shown in the following table:

Initial Gage Pressure p_1.	Final Gage Pressure p_2.	Discharge Compressed Air = Q.	Equivalent Free Air.
15 lbs.	0 lbs.	256 cub. ft.	256 cub. ft.
30 "	15 "	208 " "	416 " "
45 "	30 "	182 " "	546 " "
60 "	45 "	161 " "	644 " "
75 "	60 "	147 " "	735 " "

This table shows:

1st. As the initial pressure is increased, the discharge of compressed air *decreases*, the loss of pressure by friction remaining the same.

2d. As the initial pressure is increased, the discharge of equivalent free air *increases*, the friction pressure remaining constant.

3d. The advantage of using a high initial pressure. Thus we see from the table that under certain given conditions, 75 pounds initial pressure will discharge 147 cubic feet of air at 60 pounds final pressure, which is equivalent to 245 cubic feet at 30 pounds, whereas 45 pounds initial pressure will only discharge 182 cubic feet at 30 pounds final pressure, with the same loss by friction of 15 pounds, so that the higher initial pressure shows a gain of 63 cubic feet of air at 30 pounds final pressure, equal to 35 per cent.

If we now put the formula into the form

$$\left(\frac{Q \times \sqrt{l}}{c \times \sqrt{d^5}}\right) = \frac{\sqrt{p_1 - p_2}}{\sqrt{w}}$$

we at once see that as the value of $\sqrt{w}$ increases when the initial pressure is increased, so if we keep the left hand factor of the equation constant, that is, for a given constant volume of compressed air discharged, the value of $\sqrt{p_1 - p_2}$ must similarly increase, which shows that the loss by friction is greater at high than at low initial pressures, although the contrary has been sometimes assumed to be the case.

These deductions would seem to point to the necessity of inserting in every formula relating to the flow of elastic fluids in pipes the factor of the density of the fluid, whereby its volume of discharge varies according to the influence exerted upon that density by the greater or less amount of friction pressure absorbed, and by the higher or lower initial pressure. By this means satisfactory allowance is made for the decrease in density and increase in volume due to the increasing loss of active pressure from the beginning to the end of the pipe.

This formula also brings out the following important facts:

1st. The friction loss of pressure is proportional to the length of the pipe.

2d. The density of the compressed air in the pipe continually decreases as it flows through the pipe, while its volume proportionately increases.

3d. The velocity of flow continually increases as the air proceeds through the pipe.

In a given length of pipe the same equivalent volume of *free air* flows past every point in the same unit of time. The pressure at any such point or points is easily determined by proportion when the loss of pressure for the whole length is known When the pressure at such point has been ascertained the corresponding density and volume of compressed air at such point are easily found, as also the increasing rate of velocity of flow of the compressed air as it proceeds through the pipe.

EXAMPLE:

Pipe 4,000 feet long, 6 feet diameter.

Initial pressure, 75 lbs. Discharge = 900
Final " 15 " cub. ft. at 15 lbs.

Loss, 60 lbs. $C = 56$

The following table shows what is taking place at the beginning, end and three intermediate equally distant points (making four sections of 1,000 feet):

Number of Section.	Pressure at Beginning of Each Section. Lbs.	Compressed Air at Beginning of Each Section. Cubic Feet.	Equivalent Volume of Free Air. Cubic Feet.	Pressure and Loss at End of Each Section. Pressure. Loss. Lbs.	Compressed Air at End of Each Section. Cubic Feet.	Density at End of Each Section.	Velocity of Flow at End of Each Section. Ft. per Sec.
1	75	300	1800	60 15	360	0.3805	30.6
2	60	360	1800	45 30	450	0.3044	38.2
3	45	450	1800	30 45	600	0.2283	50.9
4	30	600	1800	15 60	900	0.1522	76.4

Co-efficients to be used. Darcy's, modified to suit the general formula here given applicable to all fluids (see page 671 of Kent's "Mechanical Engineer's Pocket Book"), are:

For diam., in.	½	1	2	3	4	5
Value of C	36.8	45.3	52.7	56 1	57.8	58.4
For diam., in.	6	7	8	9	10	12
Value of C	59.5	60.1	60.7	61.2	61.8	62.1
For diam., in.	14	16	18	20	22–24	
Value of C	62.3	62.6	62.7	62.9	63.2	

From a comparison of this general formula with several special ones for gas, water, steam, etc., these would seem to be as near as any general ones which can be devised, especially when the "slippery" nature of all such calculations relating to the flow of fluids is taken into account.

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The "Cleveland Leader" published July 22d a "Centennial Edition" in connection with the celebration of the centennial of the founding of that city, and naturally this is devoted largely to industrial matters in Cleveland.

ELECTRICAL MACHINERY.

Portable Electrically-Driven Boring and Drilling Machine.

The making of electrical machinery has supplied a good crop of new problems in machine construction, and it is of interest to note the numerous cases in which electricity has furnished not only the problem but the solution.

In our issue of January 9th we described a portable slotting machine in use at the works of the General Electric Co., for machining the faces or pads on the magnet frames for the field magnet pole pieces. The magnet frame was shown strapped down to a large T slotted floor plate to which the slotter was also strapped. We illustrate on the opposite page what is, in a sense, a companion machine to the slotter.

After the pads are faced, bolt holes are required to secure the pole pieces to the frame as well as holes for bolting the halves of the frame together and for bolting the frame down by its feet.

The drilling of such holes on pieces of the shape and size which have now been reached, will be seen to be an awkward job with drilling machines of the usual type.

The present machine is upon the same idea essentially as the slotting machine—that is, the tool is carried to the work instead of the reverse. The drilling is done while the frame is still in position upon the floor plate—the pads, as left by the slotter, being, of course, square with the plate. The drilling machine is set in position on the plate and moved from hole to hole as required—this moving being facilitated by the bale shown at the top by which the machine can be lifted about as required by the traveling crane. To provide for the heavy thrust of the drill a suitable clamping arrangement (not shown in the illustration) is provided by which the machine and the piece being drilled are securely tied together.

The machine being once set square with the face to be drilled, the adjusting screws in base and column allow the spindle to be adjusted in position for all the holes in that face.

A motor forming, in effect, part of the machine, supplies the power which is carried to the spindle by a steep pitch phosphor bronze worm wheel and Harveyized steel worm.

This system of carrying the tools to the work is receiving a good deal of attention among builders of heavy machinery, and the electrical system of driving offers obvious advantages in connection with it. In the present case it is obvious that, with the work already strapped down square with the floor plate, the drill can be brought in position for the various holes in much less time than would be consumed in adjusting the heavy semi-circular magnet frame to any fixed machine.

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The progress of the telephone is shown by the fact that while but 65,000,000 telegraph messages are sent in this country each year, the number of telephone conversations is 750,000,000. These figures include, of course, the messages sent over public lines only, as in the nature of the case the figures cannot be given for private lines.

On the Use of Small Electric Motors

BY N. S. STEVENSON.

It is a well known fact among electrical men that small motors are much less satisfactory than large ones, but this fact seems to be kept carefully guarded from the knowledge of the users of such motors. The purpose of this article is to point out the reasons for this undoubted fact.

As to the question of the minimum size of which motors can be made and still be satisfactory, no absolute answer can be given that will apply to machines of all types. If the motor is of the series type, it may be smaller than if shunt wound, providing it is intended for the same electromotive force; and the lower the electromotive force, the smaller the motor may be whether series or shunt wound.

The electromotive force is a factor that determines the size, on account of its affecting the size of the wire, owing to the fact that the power is proportional to the current multiplied by the electromotive force; therefore the higher the latter the smaller the current, and consequently, the smaller the wire. A one-horse power motor wound for one hundred volts would have the same size wire as a two horse power wound for two hundred volts, and the durability of both machines would be the same, so far as the wire is concerned. The wire is one of the weakest parts of small motors, and in fact is what principally determines their mechanical efficiency; therefore if in this respect two machines are alike they will be equally durable for all practical purposes,

although their capacities may be widely different.

The series motor can be made smaller than the shunt, because the wire is larger for a given capacity. The armature wire would be of the same size with both types, but that on the field would be very much smaller in the shunt machine. As an illustration, take a one horse-power motor wound for two hundred and twenty volts. The armature wire would be about No. 19 or 20 B. & S. gage, and if it were a series machine the field coils would be of the same size; but if it were shunt wound the field coils would be somewhere around 28 or 30 B. & S. gage.

It might be suggested that this weakness could be overcome by the use of wire larger than is necessary, reasoning that such a procedure would only add slightly to the cost; but if the wire is enlarged, the armature and field coils would have to be enlarged, so as to accommodate the extra amount of wire, and the current carrying capacity would then be greater, which is equivalent to saying that the power of the motor would be increased. And this would be the case, for all that would remain necessary to obtain a machine of larger power would be to enlarge the shaft, pulley and journals.

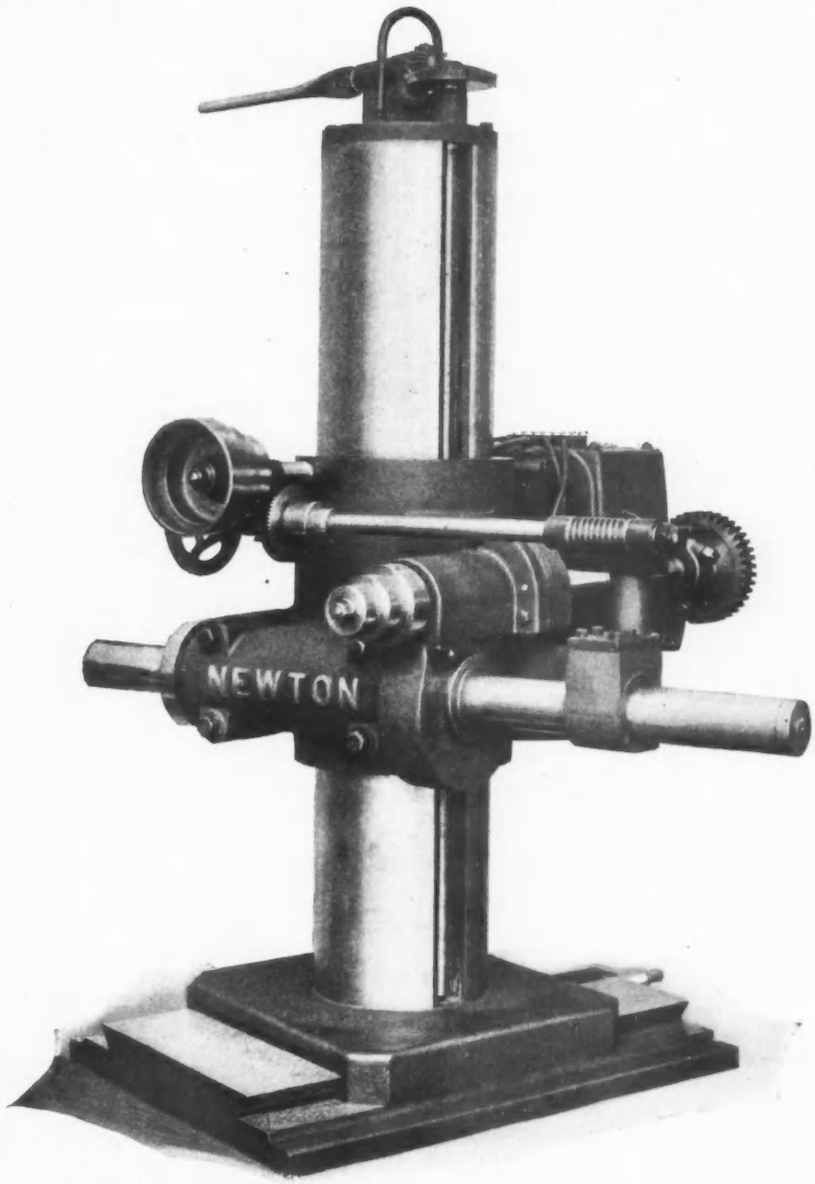
The wire is not the only weak point about small motors, although it is the principal one. The shaft, the commutator, the brushes and in fact all the working parts through the reduction in size become more frail. Although the working parts must necessarily become less substantial as the size is decreased, the strain and wear and tear also becomes much less, therefore one compensates in a very great measure for the other, and if sufficient care and skill are used in the construction the durability of these parts should be nearly equal to what it is in larger machines. The weakness of the wire, however, cannot be overcome, therefore when this becomes so small as to be easily broken, the motor can only be considered as a toy.

In most large cities, the electric lighting stations will not furnish current of less than two hundred and twenty volts for operating motors larger than one horse-power. This might lead to the conclusion that in the estimation of the engineers of these corporations two hundred and twenty volt motors are perfectly reliable down to one horse-power. This, however, is not necessarily so; the stations look out for their own interests, and as they know that these machines can be used, they refuse to furnish a lower voltage which would be more expensive to them, owing to the fact that the capacity of the street mains is decreased by a reduction in the voltage. In New York City there are a great many two hundred and twenty volt motors as small as one-half horse-power, and in some cases they give very good service, but it is very doubtful if, in the long run, they will be as satisfactory as larger machines. In view of the fact that two hundred and twenty volt shunt motors of less than two horse-power have their field coils wound with wire about as large as a hair, they cannot be very substantial, and it would seem perfectly reasonable to assume that in the long run two horse-power machines would be more economical than the smaller ones, on account of the difference in the cost of repairs. It may be safely said that motors of less than one horse-power should not be put in for steady service.

It is becoming an axiom with experienced users of motors that the secret of success is to have them of ample power. This is of much greater relative importance with small machines than with large ones, owing to the greater danger of accidental over loads with small powers. A machine consuming normally one horse power might easily double its resistance through some accidental cause, but the same could hardly be possible with a machine consuming ten horse power. And yet the increase of one horse power on a one horse power motor is as serious a matter for it as an increase of ten horse power on a ten horse motor.

In view of the fact that the resistance of light running machinery can be greatly increased by improper attention, it is clear that the prevailing tendency to couple motors directly to machines may be carried too far. With several machines on one motor, it is hardly possible that the load on all could increase to a maximum at the same time, but this would have to happen in order to produce the effect of such an increase on a machine driven by its own motor. In other words the group system involves a much smaller excess of momentary load over the average than does the individual system.

There are many cases in which it is



PORTABLE ELECTRICALLY-DRIVEN BORING AND MILLING MACHINE.

very advantageous to use direct-connected machines, and this fact is very liable to lead to the improper application of the system. The tendency of human thought is to run in ruts, and whenever a new practice comes prominently to the front it is very apt to be overdone, the assumption being that if it is good in one case it ought to be good in another, without any regard as to whether the two are similar or not. In all cases where a large power is required to drive a machine, direct connection will probably be found to be advantageous, and especially so if the work performed is intermittent; but where the machines are small, the system would in all probability prove not only the most expensive, but the most troublesome. It does not require a very strong argument to prove the correctness of this statement, for it is evident that to take care of a number of small machines will require more time and work than would be expended on one of somewhat larger size, especially when the small ones are more frail, to begin with; while as to cost, the difference would probably be two to one, or more, in favor of the single large machine.

There is one point in connection with the use of electric motors that has never received the attention it should, and that is, that in consequence of the fact that a motor will not slack up its velocity to a noticeable extent when the load is increased, or furnish any other sign by which the abnormal strain may be detected, there is always a considerable danger of a burn-out through an overload. If a motor were like a steam engine, and would simply stop when it is loaded beyond its capacity, burned-out armatures would be far more scarce than they are; but as the motor will keep on running at practically the same speed even when the load is doubled, the danger it is almost constantly subjected to should be guarded against in every way possible. With a steam engine, if the load is increased more steam is used, and if the load becomes so great that the full pressure obtainable in the cylinder cannot overcome it, the engine will stop, but no damage will be done to it. This is not the case with the motor, which does not measure out its current by the cylinderful, but takes all that comes, with no other idea than to keep up the speed until, as the load increases, a point is reached where the wire becomes so hot that the insulation becomes charred, and then the armature burns out in short order. To guard against this it is customary to use some kind of device that will open the circuit whenever the current rises above a certain point, but this is only a partial protection. The most effective protection would be to use a motor considerably larger than necessary to do the work. Such a motor, with the additional safeguard of a good circuit breaker, would not be in much danger of destruction through increased currents due to overloads. In relation to circuit breakers, it should be said that those generaliy used are not as effective as they should be. They are made so as to open the circuit when the current becomes too strong, but they should also be able to open the switch whenever the current is interrupted. It is by no means an uncommon thing for the current to stop flowing through the wires from which the motor is supplied, and if in such cases the attendant forgets to open the switch, trouble may result when the current is started again. This difficulty can be entirely overcome by using a cut-out switch that will work both ways; that is, by an increase in current or by a decrease, or total suspension of current. Cut-out switches of this type are made, but they are not used as a general rule; in fact, in most cases, an ordinary blow-out fuse is considered all that is necessary. If users of electric motors would make it a point to obtain machines of a capacity somewhat larger than actually required, and then protect them with an effective cut-out that will act when the current stops, or when it rises above a certain limit, they would get more efficient results and the cost of repairs would be considerably reduced. If, in addition to this, they would use their best judgment in the matter of direct coupling, and not connect small motors with individual machines, except in cases where the advantages of this method are self-evident, the use of electric power would prove satisfactory in every respect; and great as has been its success in the past, that in the future would be still greater.

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Letters from Practical Men.

Revolution Mark in Milling—Gaging Balls.

Editor American Machinist:

In your issue of July 16th your English correspondent, Mr. Herbert Marshall, asks for an explanation from some of your readers why it is that a perfectly true milling cutter, having a steady motion and uniform feed, will show the revolution marks when at work.

There are, perhaps, a number of reasons for this. If a milling cutter could be made perfectly true, and would remain that way under heavy cutting, there might be more of the mysterious element seen in its action. But the facts are, I think, that such tools are never perfectly true, or at least do not remain so in practice any length of time. Then, again, it may be quite impossible to make every tooth cut alike, so that one, or a group, produces a finish peculiar to itself. Those who have vainly tried to so grind and set a lathe, or planer tool, as to get a perfectly uniform finish will appreciate this feature in the milling cutter. It is true a single tool may be made to finish a surface so as to have the feed visible, but to have a series of such cutters do this would indeed seem impossible. Still another reason may be advanced which might cause a want of perfect uniformity in cutting: Should there be a difference in the torsional strength of the spindle, such as an inequality in texture would cause, it is clear that the advance of the cutter would not be regular; and hence, marks of its revolutions might be seen.

Right along in connection with the above subject comes the inevitable criticism of Mr. Hugh Dolnar's ball measurements by Tecumseh Swift. I am not anxious to mix in this controversy over the $\frac{1}{4000}$ of an inch, but think it clear that if an extreme variation of only $\frac{1}{4000}$ is allowable, then the mean variation will be but $\frac{1}{8000}$ of an inch, as Mr. Dolnar evidently means to put it.

While all of the bicycle series which you are publishing have not been read carefully by me, yet the illustrations have been such as to convey at once much information. The operation of measuring balls was of special interest, perhaps, because there was a lady in it—an exception, it

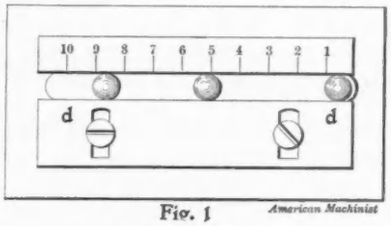

Fig. 1

BALL GAGING.

seems, in selecting the employés for these factories. But what struck me as most strange was that this evidently tedious operation was not performed in a more expeditious and perhaps a more accurate manner by an automatic device. I once had occasion to measure with a good degree of accuracy the variations to be found in the different numbers of dropped shot. To do this, two straight-edges were securely adjusted to the size of shot to be tested, as shown by Fig. 1. Any desired variation was made in the space between the two edges at *a* and *d*, as, for example, the difference between these points might be but $\frac{1}{1000}$ of an inch. Then, if this distance be divided in ten equal divisions, and a receptacle placed beneath these, the shot falling through as they passed from the narrow toward the wider end would vary in size by the $\frac{1}{10000}$ of an inch. For my purpose it was not necessary to make so close an assortment, yet in the case of accurately turned steel balls this could be easily done.

QUIRK.

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A 24-Inch Measuring Machine.

Editor American Machinist:

I send you a print of a 24-inch measuring machine adapted to setting calipers or gages more accurately to measurement than by the ordinary methods; also to be used in obtaining lengths of rods to be used for specific purposes, where correct

measurement is desired, and where limits of lengths are wanted, or test of lines already made.

Fig. 1 is a front elevation of machine, showing bed having dovetailed slideway planed its entire length. On this slideway are mounted three sliding heads. The central slide head and the one at the left are provided each with a caliper plug ⅜ x 1 inch, carefully hardened and finished exactly 1 inch long; the right-hand head is provided with micrometer which reads one ten-thousandth of an inch and can be used 1 inch in or out.

Fig. 2 is a plan of the machine, showing the measuring, plug and micrometer. On front of machine, on top of bed, is a special fine-line steel rule 24 inches long, cut expressly as a test or reference scale for me by the Darling, Brown & Sharpe Co. This special rule deserves more than a passing notice on account of its fine, smooth and uniformly sized line, making it especially valuable as a standard for reference on this machine.

Fig. 3 is an end elevation of the machine, showing, as well as Fig. 2, a rear table having a vertical adjustment to locate any work to be compared with the standard or to have lines drawn upon it from the standard.

Fig. 2 shows at the rear of standard rule on table, a 6-inch rule being compared and its errors noted. In this examination of the 6-inch rule (under lenses carried on central slide, not shown in cut) the standard scale is clamped to the central sliding head and can be moved .2 of an inch to right or left as needed. To determine the limit of error on piece being examined, or where lines are desired to be made, the right-hand sliding head having micrometer set at zero is brought into contact with plug of center slide, and fastened to slideway by means of gib binding screw. Then amount is determined by micrometer reading. When parallel lines on jigs or similar work are wanted to be made, then the clamp on center slide head is removed (which holds and carries standard rule), and in its stead a special vernier plate reading to one ten-thousandth of an inch is put on. Then the reference rule is held in place by the two screws at each end.

You will observe that all caliper measurements, inside or outside, are readily obtained (except less than 2 inches outside measurement) by means of the caliper plugs direct. Suppose a case: We want to originate a gage rod 22 inches long. We first slide central head to left so that the vernier reads to first line on standard rule; then the plug of left head is brought into contact with plug of center head and fastened; next center head is moved to the right so that vernier reads 23 inches. Then it follows, if we have set correctly, we have an exact distance of 22 inches between plugs, to which distance we carefully finish the rod. To prove our setting by vernier is correct, we take a 12-inch test rod and set plugs of left-hand head and center head to the exact distance of 12 inches (previous to moving center plug to left we brought micrometer screw into contact with it). Now, if a 10-inch rod be found to fit space between center plug and micrometer screw end, it follows that when center plug is carried back to original position it is 22 inches between caliper plugs.

By the above arrangement, with the standard rule, it requires but few test lengths to obtain and prove any measurement inside of 24 inches, internal or external, in ten-thousandths of an inch. When better opportunity affords I may be able to give more data of the use of machine.

FRANCIS W. CLOUGH.

Springfield, Mass.

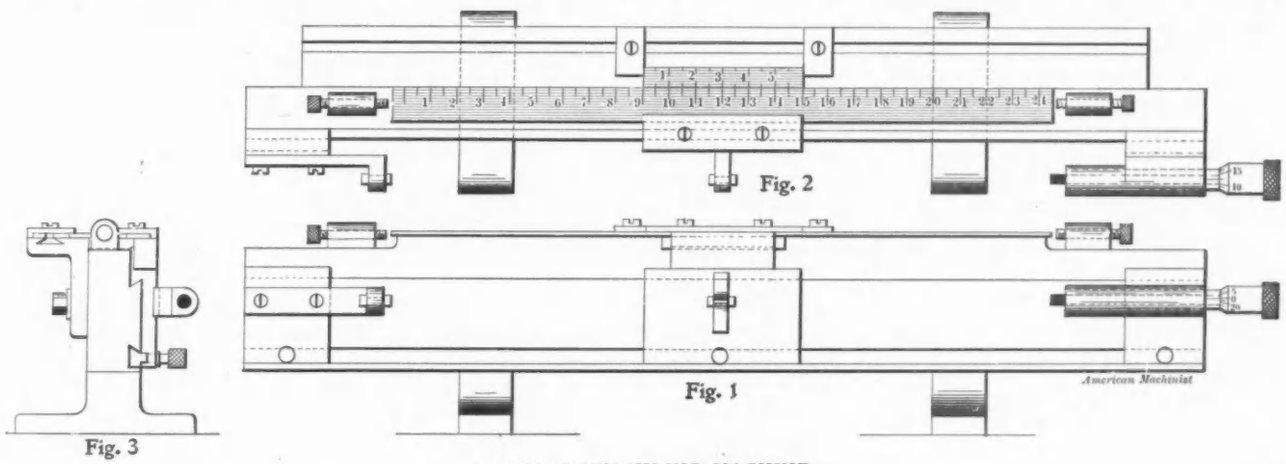

Fig. 1

Fig. 2

Fig. 3

A 24-INCH MEASURING MACHINE.

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A Better Engineer's Pocket Book.

Editor American Machinist:

In your issue of July 30th one of your correspondents calls for a better Engineer's Pocket Book, one that is "up-to-date." I would call his attention to "Kent's Engineer's Pocket Book," which is good and the best of the good, and, furthermore, right up-to-date. The only thing about it is that it contains a great deal more than the aforesaid correspondent apparently wants to know; a feature that we, who are not engaged in his particular line of work, heartily appreciate. As to thumbing the book to pieces from continual references to the mathematical tables, I am pretty sure that by the time the volume becomes unserviceable for that reason there will have been issued a new edition of the pocket book, if not more than one, judging by the frequency with which new editions of Trautwine, a like hand book for civil engineers, have been issued; both books being published by the same house.

I prefer having information condensed as far as possible into one volume, because of less desk or drawing-board space occupied, and because of greater ease in becoming familiar with the contents of a single book. No man can "speak authoritatively upon every subject," and the author of the Mechanical Engineer's Pocket Book cited does not lay claim to omniscience, but in nearly every case he cites his authority—a feature contained in no other pocket book that I have seen. Certainly, a pocket book will not do one's thinking, and where practices are at variance it is oftentimes of considerable use to us to know what A says, what B says and what C says; whether their data are irreconcilable or not depends upon one's penetration, experience and judicial sense very largely.

In a valuable article on "Coiled Springs," by E. T. Adams, in the "American Machinist" for May 21st, the writer refers to Begtrup's "excellent table," regretting that "even this is not now generally available." The writer of the paper and some of your readers may be glad to know that that is to be found in "Kent's Pocket Book," in almost the same form as originally published in the "American Machinist."

It would be greatly to the advantage of engineers if they would keep better posted on the new books published on engineering subjects. The reviews appearing in your columns and in other leading jour-

nals are very helpful, especially when one is not near a large city where book stores carrying large lines of technical books offer advantages of inspection of the new books.

W. S. D.

Montreal, Que.

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We have received Volume II. of the "Engineering Index," which covers the years 1892 to 1895, inclusive. In this book will be found, alphabetically indexed, most of the more important engineering articles and professional papers that have appeared in print within the period named, and in many cases there is sufficient information about the article to enable one to judge something of its character and probable value to him. This is published by the "Engineering Magazine" in connection with its technical index and in continuation of the work formerly carried on by the "Journal of the Association of Engineering Societies," under the direction of Prof. J. B. Johnson, of St. Louis —a work which has been important to engineers and seems likely to be well carried on in present hands.

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One of the knotty problems connected with patents is the extent to which the user of a patented article may repair it without infringement. On its face, it would appear that he should have no restriction; but when it is considered that repairs run by insensible degrees into reconstruction, it will be seen that the rights of the inventor might be easily infringed. We have known the most innocent repair shops to become by degrees practically factories. For a time the original makers' machines would retain their identity, like the boy's jack-knife which had new blade and handle, but kept the old spring; but gradually even this was lost, and little pretense was kept up that new machines were not made. The dividing line between the user's and the maker's rights is perhaps clear to a lawyer, but no mechanic can locate it.

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James Dredge, editor of "Engineering," of London, has been appointed Commissioner-General for Great Britain at the International Exhibition to be held at Brussels.

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Demoralization of trade, severe competition, stringency of money market are all bad enough, but all of them together are never as absolutely fatal to a manufacturing enterprise as internal dissensions with their usual accompaniments of quarrels, injunctions and retirement of the most valuable men. This latter is what seemed to trouble the Liberty Cycle Co., whose factories were recently closed. It is thought that if the company can resume operations, its assets will be sufficient to put it on its feet again; otherwise not.

Practical Solution of Fourth Degree Equations.

The linear equation of the fourth degree occasionally occurs in practical computation, and may be depended upon to make trouble every time. The matter is deemed of small consequence by writers of text books on algebra, and is seldom treated of. When given at all it is put in proper shape for instruction and demonstration, and in very poor shape for practical application, and the computer who has not a continual use for the matter must practically learn it anew each time it comes up. Sturm's theorem, Horner's method and the various rules of the "theory of equations" are valuable and always available, but they are special processes that must be learned each time, and they are not by any means as easy as they appear to be when required for the cases that actually come up in business.

The following process is entirely by substitution in formulæ, a process that is well understood by any computer without special study, and, although it involves much work, the labor is of simple character. It is no small undertaking to solve any fourth degree equation by any known method:

The Method, without demonstration, is as follows:

Given, the biquadratic in its most general form:

$$x^4 + ax^3 + bx^2 + cx + d = 0$$

Required, its four roots.

Compute the four auxiliary quantities.

$$H = \frac{ac}{12} - \frac{d}{3} - \frac{b^2}{36}$$

$$K = \frac{bd}{6} - \frac{b^3}{216} - \frac{c^2}{16} - \frac{a^2 d}{16} + \frac{abc}{48}$$

$$M = \frac{3a^4}{256} - \frac{a^2 b}{16} + \frac{ca}{4} - d$$

$$N = \frac{a^3}{8} - \frac{ab}{2} + c$$

The bulk of the labor is upon these, and it may be remarked in passing that a calculating machine will save half the time and also half the mental labor required by logarithmic or other computation.

Compute w. We must use one of two different methods.

If H^3 is positive, or if it is negative and also numerically equal to or less than K^2, we use Cardan's formula

$$w = \sqrt[3]{-K + \sqrt{K^2 + H^3}} + \sqrt[3]{-K - \sqrt{K^2 + H^3}}$$

If H^3 is negative, and also numerically greater than K^2, Cardan's formula becomes unmanageable and we must use the trigonometrical method

$$\sin P = \sqrt{-\frac{K^2}{H^3}}$$

$w = \pm 2\sqrt{-H}\sin\frac{1}{3}P$, and it is positive when K is positive, or negative when K is negative.

Having found w,

$$\text{compute } V = w + \frac{b}{6} - \frac{a^2}{16}$$

$$\text{and } m = \sqrt{V^2 + M}$$

and then the four required roots

$$x_1 \text{ or } x_2 = -\frac{a}{4} + \frac{N}{4m} \pm \sqrt{\left(\frac{N}{4m}\right)^2 - V - m}$$

$$x_3 \text{ or } x_4 = -\frac{a}{4} - \frac{N}{4m} \pm \sqrt{\left(\frac{N}{4m}\right)^2 - V + m}$$

A Simple Example

With integral coefficients and roots:

$$x^4 + x^3 - 7x - x + 6 = 0$$

$$H = -\frac{1}{12} - \frac{6}{3} - \frac{49}{36} = -\frac{31}{9}$$

$$K = -\frac{42}{6} + \frac{343}{216} - \frac{1}{16} - \frac{3}{8} - \frac{7}{48} = -\frac{154}{27}$$

$$M = +\frac{3}{256} + \frac{7}{16} - \frac{1}{4} - 6 = -\frac{1485}{256}$$

$$N = +\frac{1}{8} + \frac{7}{2} - 1 = +\frac{21}{8}$$

$$\sin P = \sqrt{\frac{23716}{29791}},\ P = 63^\circ\ 9'\ 18''$$

$$w = -\frac{2}{3}\sqrt{31}.\ \sin 21^\circ\ 3'\ 6'' = -\frac{4}{3}$$

$$V = -\frac{4}{3} - \frac{7}{6} - \frac{1}{16} = -\frac{123}{48}$$

$$m = \sqrt{\left(\frac{123}{48}\right)^2 - \frac{1485}{256}} = +\frac{7}{8}$$

$$x_1 \text{ or } x_2 = -\frac{1}{4} + \frac{3}{4} \pm \sqrt{\frac{9}{16} + \frac{123}{48} - \frac{7}{8}} = +2, \text{ or } -1.$$

$$x_3 \text{ or } x_4 = -\frac{1}{4} - \frac{3}{4} \pm \sqrt{\frac{9}{16} + \frac{123}{48} + \frac{7}{8}} = +1, \text{ or } -3.$$

A General Example.

But such simple cases, with integral roots and coefficients, never occur unless selected for examples, and the following is a better illustration of the work usually required:

Given, $x^4 - 1.4127\,x^3 + 3.7160\,x^2 + 18.1214\,x - .9615 = 0$

Compute $H = -2.13334 + .3205 - .38354 = -2.19638,$

$K = -.59549 - .237560 - 20.52407 + .1199303 - 1.981874 = -23.21906,$

$M = +.046675 - .463506 - 6.40002 + .9615 = -5.855351,$

$N = -.352420 + 2.62480 + 18.1214 = +20.39378,$

$$w = \sqrt[3]{23.21906 + \sqrt{539.12475 - 10.5955}} + \sqrt[3]{23.21906 - 22.98975} = +4.20054,$$

$$V = +4.20054 + .61933 - .12473 = +4.69514,$$
$$m = \sqrt{22.0443 - 5.8554} = +4.02343$$
$$x_1 \text{ or } x_2 = +.3532 + 1.26719 \pm \sqrt{1.60577 - 4.69514 - 4.02343} = +1.62039 \pm 2.6672\sqrt{-1}$$
$$x_3 \text{ or } x_4 = +.3532 - 1.26719 \pm \sqrt{1.60577 - 4.69514 + 4.02343} = +.0525, \text{ or } -1.8805.$$

DEMONSTRATION.

Given, the general biquadratic equation with the second term removed

$$x^4 + bx^2 + cx + d = 0$$

Assume the quadratic factors $x^2 + Ax + B = 0$

and $x^2 - Ax + D = 0$

and form the biquadratic product

$$x^4 + (B - A^2 + D)x^2 + (AD - AB)x + BD = 0$$

Equating coefficients, we have

$$B - A^2 + D = b$$
$$AD - AB = c$$
$$BD = d$$

from which, by elimination, if we assume $B = n + \sqrt{n^2 - d}$, and $D = n - \sqrt{n^2 - d}$, we can easily obtain either n or A in terms of the auxiliary cubic equations

$$n^3 - n^2\frac{b}{2} - nd + \left(\frac{db}{2} - \frac{c^2}{8}\right) = 0 \quad \text{Ferraris' auxiliary}$$

$$\text{or } A^6 + A^4 2b + A^2(b^2 - 4d) - c^2 = 0 \quad \text{Descartes' auxiliary.}$$

Having solved these cubics, we get the biquadratic roots from

$$x_1 \text{ or } x_2 = +\frac{c}{4\sqrt{n^2 - d}} \pm \sqrt{\left(\frac{c}{4\sqrt{n^2 - d}}\right)^2 - n - \sqrt{n^2 - d}}$$

$$x^3 \text{ or } x^4 = -\frac{c}{4\sqrt{n^2 - d}} \pm \sqrt{\left(\frac{c}{4\sqrt{n^2 - d}}\right)^2 - n + \sqrt{n^2 - d}}$$

or from

$$x_1 \text{ or } x_2 = -\frac{A}{2} \pm \sqrt{-\frac{A^2}{4} - \frac{b}{2} + \frac{c}{2A}}$$

$$x_3 \text{ or } x_4 = +\frac{A}{2} \pm \sqrt{-\frac{A^2}{4} - \frac{b}{2} - \frac{c}{2A}}$$

which are obtained by putting B, D and A in the assumed quadratic factors and solving. The given working method can be derived from this general process by simple changes of arrangement not necessary to explain at full length, the second term is to be restored, and w is either one of the roots of the cubic.

There are other solutions by similar means, but they present no new features; in fact, all biquadratic solutions yet proposed are practically variations of the same general method. Thus, if we assume $B = \sqrt{n^2 + d} + n$, and $D = \sqrt{n^2 + d} - n$, we get another auxiliary cubic and another set of biquadratic roots. If, in the assumed quadratic factors, we make $A = 2\sqrt{t}$, we get Euler's auxiliary cubic.

Boston, Mass. GEORGE B. GRANT.

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Mariner's Automatic Boiler Feed.

"The Engineer" for July 31st contains a description of a new automatic boiler feed now being applied to the Yarrow torpedo boats. It is well known that these boats are fitted with sectional boilers, and the small amount of water which they contain, together with the great fluctuations in power required of the engines, combine to render hand regulation of the feed very unsatisfactory.

Mr. Mariner's device is one of those short cuts to the solution of a problem which we are accustomed to think are peculiarly characteristic of the work of American inventors, but the Englishman got there this time.

The feed apparatus is an ordinary Worthington pump with a special steam pipe of its own, having independent connection with the boiler. This pipe is carried inside the boiler, and has its entry end located at the desired water level, and that is all there is of it. If the water line is below this level the pump is supplied with steam and works rapidly; whereas, if the water line is high, so as to submerge the end of the pipe, the steam cylinder of the pump is supplied with water, and the greater resistance of the pipe, valves and ports to the motion of the water causes the pump to slow down, in fact to almost stop. The satisfactory action of the device depends, of course, on the well-known fact that a Worthington pump will act without failure when supplied with water in its steam cylinder.

The entry end of the pipe is placed within a perforated cone, within which the surging of the water is not felt, and the vertical position of its end can be adjusted at will by an adjusting screw within reach of the fireman, so that the water line can be changed as desired.

There is, apparently, some waste of heat due to the abstraction of water from the boiler; but this being at higher temperature than the feed water, is used to increase the temperature of that water, and so is returned to the boiler.

"The Engineer" states that during a three hours' official trial at full speed, of the new torpedo-boat destroyer "Santa Fé," the feed apparatus was not once touched or interfered with.

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The End of a Famous Foundry.

The end of Soho Foundry, the famous works of Boulton & Watt, the cradle of the steam engine, and the first mechanical engineering shops the world ever saw, recently broken up and brought to the auctioneer's hammer, conjures up many memories of the past, and, whether viewed in the light of the historical associations recalled or the lessons of the changes time brings, is well worthy of some passing comment at our hands.

Soho is about two miles north of Birmingham, and was until the middle of the last century a barren heath and rabbit warren, the sole relic of the past, the well of the warrener's hut, still existing. On this spot Boulton erected his famous factory, about 1760, and devoted his attention to the manufacture of metal wares and similar articles. This factory, the "Soho" properly so called, was dismantled as far back as 1850-51, many of the tools being removed to "Soho Foundry," about a mile distant from "old Soho." It is with the fortunes of the "Soho Foundry" that we are now concerned, as this famous establishment, now sold, had survived its parent by nearly half a century. Soho Foundry was built in 1775, and covered an area of over nineteen acres; its foundation was due to the rapidly extending business of Boulton & Watt, who found their existing works quite unable to cope with the ever-increasing demand for the new steam engine.—"Chambers's Journal."

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Sample of an Unanswerable Question.

New York, Aug. 1, 1896.

Will you kindly advise me through the columns of the "American Machinist" as to what Gears to use to the one I have for running her but one turn in a minute it is 12" in diam. has 92 Teeth and 8 pitch and gets the Power from a spring.

And oblige, yours respectfully,

A HAMMER.

N. Y.

The above is a fair sample of a good many inquiries we receive. The question is, of course, unanswerable in its present form, and we cannot write to the questioner to ask him for further data, because we do not know his address. Such letters must perforce go into the waste-basket, and thus the writers of them no doubt think we deliberately choose to ignore them.

American Machinist.

Published every Thursday
by the

American Machinist Publishing Co.,
256 Broadway, New York.

Angus Sinclair, Pres't. John A. Hill, Treas.
C. A. Hansmann, Sec'y.

C. P. Day, Manager Adv. Dept.

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Edward P. Buffet,
} Associate Editors.

A. L. Donnell, Dept. of Illustration.

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Space in advertising pages only is for sale.

We invite correspondence on subjects pertaining to machinery.

Name and address must always be given, though not necessarily published.

Communications for or relating to the reading columns should be addressed to the Editor. All business communications should be addressed to the Company.

Subscribers can have their mailing address changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once. Date on wrapper denotes week with which subscription expires.

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$3.00 a year in advance, postage prepaid in the United States, Canada and Mexico.

$4.00 a year to other countries, postage prepaid.

Entered at Post Office, New York, as second-class mail matter.

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Engineering Students from the Shops.

Our readers will remember the discussion in our columns in which we advocated the admission to our engineering schools of students from the shops alongside of those from the preparatory schools, our point being that shop experience should be accepted as the equivalent of scholastic acquirements.

We are glad to announce that Prof. W. T. Magruder, who has charge of the department of mechanical engineering at the Ohio State University, is to read a paper on this subject at the August 20th meeting of the Society for the Promotion of Engineering Education. We regard this as a matter of supreme importance, believing as we do, that the engineering schools are at present turning their backs on the best available timber for making into engineers, with a resulting loss to great numbers of men of great natural capacity, and to the country's progress as well.

Professor Magruder is in full sympathy with our own position, but informs us that he finds a good deal of difficulty in arranging the schedule of studies so that the two classes of students can work together. We are and have been from the start, fully alive to the difficulties now encountered by Professor Magruder, but we do not believe them insuperable. As a matter of fact, we should like to see some school with the courage to organize its schedule especially for the students from the shops, and then make those from the schools do the squeezing and accommodating always consequent upon being out of time with one's course, instead of, as now, the students from the schools being regular and all others forced to adjust themselves to the schedule as best they can. This is perhaps too much to expect, but as regards the accommodation of both classes on equal terms, "where there is a will there is a way." Professor Magruder obviously has the will, and we are confident he will find the way.

This is a movement in which we have long taken the greatest interest, and we shall endeavor to keep our readers fully informed as to its progress. We believe the school which enters upon it will jump to the front of public favor, and will score a real advance in educational progress.

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The Machine Constructor's Influence on Prices.

The politicians and the political papers are having much to say these days about changes in values and in prices of different commodities. In these discussions the part taken by the engineer and mechanic in cheapening the necessities and comforts of life seems likely to be largely overlooked, and the "American Machinist" is certainly justified in calling attention to the fact that machine constructors have been the most powerful factor in this work of advancing civilization. In fact, taking the generally accepted view that the great object and end of civilization itself is to make it easier for the children of men to secure the necessities and enjoy the luxuries of life, then machine constructors—the men who have made it possible to manufacture power in unlimited amounts and to guide and control that power to useful ends—are the creators of modern civilization. It is they who have elevated mankind in general above the plane of competition with brutes in the exertion of brute force.

Steam power commenced by relieving the human family of a large share of its drudgery, and it is advancing further every day toward complete emancipation as electrical and other inventors find new ways of applying its energy; compressed air and the steam drill have greatly reduced the labor required, and consequently the cost of mining; improvements in blast furnace practice and in other metallurgical processes give us cheaper iron and steel; while, finally, the general use of the turret machine, milling machine, gang drilling machine, automatic screw machine and other modern machine-shop appliances have enabled us to turn this cheaply produced steel into progressively cheaper machinery, the object of most of which machinery is to produce wealth—houses, furniture, boots and shoes, clothing, wheat and countless other articles of use and luxury at constantly lessening cost. In short, we may say that the ultimate object of all the marvelous progress in the arts which we now witness is to make it easier for men to get those things which make life worth living; and that means simply to reduce their labor cost.

The papers presented and the discussions held in the meetings of the American Society of Mechanical Engineers, and such articles by practical mechanics as are appearing in our columns, may and do greatly interest those who have a taste for mechanical matters, pursue knowledge of mechanics for its own sake, and enjoy comparisons of views and of practice; but such matter does no good whatever for humanity in general, or for the advance of civilization, except in so far as it cheapens—makes easier of attainment—the comforts of life, and renders easier man's battle for control over the forces of Nature. Even in agricultural operations, with the modern gang plow and gang drill used by the farmer, and with his self-binding reaper, he rides over the fields while he plows, sows, reaps and binds his wheat. By these appliances wheat is much more cheaply produced than when earlier and cruder implements were employed; but this can benefit wheat consumers only by making wheat lower in selling price.

There are many articles of use and luxury to the production of which machinery cannot well be applied; these do not materially decline in price, but, on the contrary, often advance. Land is a notable example; it can be neither increased nor decreased, and, instead of declining in value by reason of improved processes of production, its price is actually increased by them. Every improvement in mining machinery tends to increase the amount men can pay for the use of mining land, and, consequently increases competition for its use and its price. Improved methods of building construction have had a similar effect upon land values in New York and other large cities.

It is clear to the machinist that, with the exceptions mentioned, machinery tends to make things cheaper, because lower in labor cost, and therefore easier for men to get. Broadly speaking, this is certainly desirable, and we think machine constructors should receive far more credit for it than they generally get.

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A Machine for Solving Equations.

Mr. Grant's article in another part of this issue, giving a "Practical Solution of Fourth Degree Equations," will look somewhat fearsome to many, especially in such hot weather as we are having. It is not quite as bad as it looks, but still a good many will skip it, and we can afford to devote some space to this article, showing

how a practical man gets over, or at least very much simplifies, a mathematical operation which must sometimes be gone through with, and which most men promptly forget as soon as they cease to have constant use for it. Our non-mathematical friends can, however, take courage from the fact that this article is only preliminary to an illustrated description of a machine Mr. Grant has devised for solving such equations, and our readers who cannot solve them with a pencil may then take revenge by constructing a machine which will solve them without a pencil.

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We are unable to present an installment of "Bicycle Tools" this week, and probably will not be able to do so next week. Various causes—mainly extreme heat of the weather—have combined to cause this hiatus; but we shall soon resume the series, and shall also, we are glad to say, soon conclude them, so far as publication in serial form is concerned. No editor, who is alive, likes long-continued series of articles, but sometimes they are necessary. Few articles ever before told so much about a branch of industry, especially a new industry, and we know that very many of our readers—even those not directly interested in bicycles—have followed the articles carefully for the sake of the general information on tool-making and manufacturing processes to be found in them. Other good friends of the paper—even some whose income has been derived for a few years past mainly from bicycle shops—have thought we were devoting too much space to bicycle-making. In deference to these, we have desired to close the series as soon as practicable, and think it can be done in two more installments. After that we shall take up subjects connected with bicycle manufacturing as occasion offers, and will publish articles on ball-making, drawn-work, brazing, etc., but not as a continued series.

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Much interest is felt among bicycle men as to what the leading makers are likely to do next year, and there is much speculation regarding it. We have it upon good authority that the Pope Manufacturing Company will next year make the "Hartford" wheel as good as the "Columbia" is now, and possibly somewhat better, but will sell it at or somewhere near its present list price, while some special feature or features which they can control will be added to the "Columbia" and its price kept up. They will make a wheel in which bevel gears will take the place of the chain, but whether this is to be the feature, or one of the features, of the '97 "Columbia" we cannot say. It is known, too, that the Pope Company are getting ready to bring out an auto-mobile carriage.

Questions and Answers.

Name and address of writer must accompany every question. Questions must pertain to our specialties and be of general interest. We cannot undertake to answer questions by mail.

(146) J. G., Milwaukee, Wis., asks: What is the greatest length of bar iron that can be rolled in this country for shafting, say, from 2 inches round and upwards? A.—We do not know; but Jones & Laughlin, of Pittsburg, inform us that they can roll 2 inches round as long as 60 feet, 6 inches round as long as 35 feet, and intermediate sizes in proportion. They make nothing but steel, however.

(147) Novice asks: 1. For the meaning of the expression "ampere turns," introduced in Mr. Mason's article on "Electrotechnics," which appeared in our issue of February 20th. A.—"Ampere turns" means the product of the amperes of current through the coil by the number of turns of wire. In the case of a series generator, the number of amperes is the total current of the line. In the case of a shunt machine, the amperes through the field are such a part of the total current as it is desired to use for energizing the field. The amperes being decided on, the number of turns is found by dividing the ampere turns by the amperes. 2. Name some good text-book on this subject.—A.—"Electric Transmission of Energy," by Giesbert Kapp; "The Dynamo," by Hawkins and Wallace, and "Dynamo Electric Machinery," by S. P. Thompson.

(148) J. H. T., Chicago, Ill., asks: How would the friction compare between a shaft 1¼ inches in diameter at 100 revolutions per minute, and one 2 inches in diameter at 200 revolutions per minute, the weight remaining the same? The diameter of the shaft would have little effect, would it not? A.—If the weights of the shafts were the same, then the retarding force of friction would be the same in each case. This force, however, acts at a greater radius, or, in other words, at the end of a longer lever in the case of the 2-inch shaft; and, therefore, what engineers call the "moment of the force" will be greater. It will be greater in proportion to the diameters, or as 2 inches to 1¼ inches. Then, if the 2-inch shaft runs at twice the speed of the 1¼-inch shaft, it will take, not more force, but more power to overcome the friction, simply because the force must act through a greater distance in a given period of time. Under the conditions you name, and assuming that the co-efficient of friction remains the same, the force required to overcome frictional resistance would therefore be the same in each case if applied at a radius equal to the radius of the shaft itself; but the power required to overcome the frictional resistance of the 2-inch shaft, running at 200 revolutions per minute, would be, relative to that for the 1¼-inch shaft, running 100 revolutions per minute, as 2" × 200 is to 1¼" × 100, or as 4 to 1¼.

(149) W. L. C., Meriden, Conn., has a well delivering 700 gallons of water per minute at 61 degrees temperature. His shop, 98 feet long, 36 feet wide and 13 feet high, is often as hot as 92 degrees, and he wants to know if the water cannot be made to cool the air. A.—The shop contains 46,000 cubic feet of air, weighing 3,500 pounds. The specific heat of air at constant pressure is .2375. If the air is to be cooled 20 degrees, 3,500 × 20 × .2375 = 16,600 heat units must be extracted from it. Seven hundred gallons of water weigh 5,800 pounds. If the water is to be warmed 10 degrees, 58,000 heat units per minute are available: $\frac{58000}{16600} = 3\frac{1}{2}$ approximately. In other words, the water would cool the entire body of air in the shop 3½ times per minute, which is far in excess of the requirements, as when once cooled it would be easy to keep it so. To get the apparatus to work, however, would not be so easy. A mere air tank, as you suggest, would not have enough cooling surface. The transmission of heat through plates between water and air in motion, is at the rate of about 5 heat units per square foot per hour, or $\frac{1}{12}$ heat unit per square foot per minute. To carry 58,000 heat units per minute would require $\frac{58,000}{1\frac{1}{2}} = 44,000$ square feet of surface. This, again, is largely in excess of the requirements after the shop is cooled down. The actual surface necessary is not easy to get at, but the above figure will show that the apparatus for surface cooling as proposed would be a formidable affair. Spray cooling would be more promising.

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Business Specials.

Transient Advertisements 40 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Gear wheels, gear cutting. Grant; see page 12.

Forming Lathes, Mer. Mach. Tool Co., Meriden, C

Milling Machs. Kempsmith Co., Milwaukee, Wis.

Honest Mach. Oils. F.S. Pease Oil Co., Buffalo, N.Y.

Engine Castings ¼ to 2 H. P. Finished boilers and engines. Grant Sipp, Paterson, N. J.

Aluminum and Brass Castings, Machinery Name Plates. Twining Campbell, Paterson, N. J.

Agents Wanted—New book. Machinist and Tool Makers' Instructor. T. F. Covert, Beaver Falls, Pa.

Selden Packing for stuffing box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Duplex and special gear cutters, counterbores, cutter and surface grinders, vertical millers, hand punches and shears. R. M. Clough, Tolland, Conn.

Patent Soliciting of High Class.—D. Walter Brown, Counsel in Patent Cases, 111 Broadway, New York. Send for "Brief History of Patent Legislation."

For Sale or Rent—Foundry and Machine Shop with additional land; in good condition and well equipped for medium heavy work. Capacity of foundry, seven tons per day. Located on railroad within eight miles of New York. Terms easy. Call or address, Room 41, 22 William st., N. Y.

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Steps to be Taken to Enlist Machinists in the United States Navy.

We frequently receive inquiries as to the proper method of applying for enlistment as machinist in the United States Navy, and give below full particulars. We think that most of those who inquire how to get in and go in, afterwards are more anxious as to the method of getting out, but "that is another story."

If anyone is desirous of entering the navy as a machinist, and lives near any one of the navy yards where a receiving ship is located, he should apply on board said receiving ship, where he will be subjected to an examination. If the person lives at a point remote from any navy yard having a receiving ship, he can get instructions by applying to the Bureau of Navigation, Navy Department, Washington, D. C.

The following is a list of navy yards

having receiving ships, with the name of the ships at each yard:

Navy Yard.	Name of Receiving Ship.
Boston, Mass.	"Wabash."
Brooklyn, N. Y.	"Vermont."
League Island, Pa.	"Richmond."
Norfolk, Va.	"Franklin."
Mare Island, Cal.	"Independence."

Men physically and otherwise qualified are enlisted as Chief Machinists, at $70 per month; Machinists, first class, at $55 per month; second class, $40 per month.

The term of enlistment is for three years.

Persons enlisted for the naval service must be of robust frame, intelligent, of perfectly sound and healthy constitution, free from any physical defects or malformation, and not subject to fits.

Physical examinations are made by a naval surgeon at the place of enlistment.

Persons are not enlisted as landsmen if over the age of twenty-five, unless they possess some mechanical trade; nor after thirty-five, even though possessing a trade.

No person will be enlisted who does not understand and speak the English language.

No allowance will be made for traveling expenses, whether accepted or not.

A candidate for enlistment as a machinist must be a machinist by trade, must know the names and uses of the various parts of marine engines and boilers, and must be able to perform work with various tools in a machine shop, including bench work.

He must be able to write legibly and must understand arithmetic.

He must be physically sound, and at the date of first enlistment must be not less than twenty-one nor more than thirty-five years of age.

Machinists who have had no experience at sea with marine engines will be enlisted as "Machinists, second class."

Machinists who have had experience at sea with marine engines for one year may be enlisted as "Machinists, first class."

No person will be enlisted as Chief Machinist unless he holds a permanent appointment as such.

The examination of candidates for enlistment as machinists, regarding their knowledge of engines and boilers, must be made in the engine-rooms of ships; and regarding their knowledge of machine work, in the work shops of navy yards.

Chief Machinists will have charge of engine-room watches. Machinists, first class, will, if qualified, be given charge of an engine room watch when there are not a sufficient number of Chief Machinists on board to perform this duty.

Machinists, second class, will be assigned to duty as water tenders and oilers. All machinists will perform such other duties as may be assigned them.

Compound Slide Rules.

The remarkable increase in interest in the slide rule is shown in no better way than in the manufacture which has sprung up of special instruments for special purposes.

Many as are the problems for which the usual form of rule is adapted, it can solve at one operation only problems involving at most three factors—or four, counting the answer—and it requires that the relationships of these quantities shall be in simple proportion, or as the squares or square roots of one another. Of course, problems containing more than three factors can be solved by attacking them piecemeal, and it is easy to construct rules for problems containing more complicated relationships; but the restriction of three factors would still hold, and rules could not be made for solving problems of much complexity at one operation. By the happy expedient of compounding the slide, the number of factors to be handled can be raised to five—or six, counting the answer—and the applicability of the slide rule principle is greatly extended.

This device of the compound slide was, we believe, invented by Mr. Wm. Cox, whose fluid flow computer has been under discussion in recent numbers, and it has been applied by him to a large number of uses. He has, in fact, designed upwards of fifty special computers. Some of these were prepared for individuals and are not articles of manufacture, but a good many are offered to the general public. Of these, some of the most useful are for calculating the horse-power of steam engines, boilers and water wheels, flow of water by Kutter's and D'Arcy's formulas, earthwork, strength of beams, transmission gearing, steam radiators, and various electrical calculations.

The subject is also receiving attention in England, and we are in receipt of a compound slide rule from Mr. C. N. Pickworth, of Manchester, intended for calculating the power of steam and gas engines, either from the cylinder end or from the load on the friction brake. Mr. Pickworth's instrument has been very well received in England, we are informed. It is more compact than Mr. Cox's instruments, with both advantages and disadvantages growing out of that fact. It is easily carried in the pocket (and is, in fact, provided with a case for that purpose), but requires more careful scrutiny in using.

These computers are of decided utility to anyone having many problems to solve of the kinds for which they are intended. Of course, unlike the slide rule, they are not universal instruments, but each one is adapted to one or to a closely related group of problems. We shall be much surprised if their use does not largely increase as they become known. One advantage which Mr. Cox's instruments possess over the plain slide rule is that they avoid all difficulty over the decimal point. The results are given in absolute figures which cannot be misread. Another feature is that the problems can be worked in any direction. For instance, if the size and steam pressure of an engine are given the power can be determined, or if the power and pressure are given the size can be found, and so, with the size of engine and the power known, the mean effective pressure can be read off.

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According to an article by Mr. Burton E. Greene, in the "Engineering Magazine" for August, one of the chief reasons for the lack of profits in the electrical manufacturing business has been the rapid improvement of electrical machinery. Progress has been so fast that unsalable machinery has been constantly left on the maker's hands. In some cases obsolete machinery to the value of $500,000 has thus been on store in a single factory. About the only company which did not have to face large losses from this cause was the "Brush, which, after developing a successful arc-lighting system, was content to let well enough alone, and thereafter did but little experimenting.

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A pang of regret will be felt by many over the fact that the historic railway suspension bridge at Niagara Falls is to be replaced by a steel arch bridge. The old bridge is the first railway suspension bridge ever constructed, and has been a landmark at Niagara Falls since 1855. It is not, however, generally known that but little of the original bridge beyond the cables and anchorages still remains. In 1880 the original timber stiffening trusses were replaced with steel, and in 1886 the stone towers were likewise replaced with steel. Traffic was maintained, however, during both these reconstructions, and the bridge has afforded constant service since its completion over forty-one years ago. The new bridge has become a necessity from the growth of traffic, and will be a double-track structure—the old one having but a single track.

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The Ohio penal authorities are having the same difficulties in carrying out the law regarding electrical executions that was experienced in New York—the unwillingness of manufacturers to supply the machinery for the purpose. On the surface, the reason is the "unwillingness to degrade a noble science," but possibly the circumstance that it advertises the capacity of the machine to kill may have something to do with it. We wonder if any cordage manufacturer ever considered his business degraded by the use of hemp on the scaffold?

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The steamship "St. Paul," of the American Line, arrived at the Port of New York

Friday, the 14th inst., completing the fastest trip yet made between Southampton and this country. The time was 6 days 31 minutes, and the average speed was 21.08 knots per hour. This lowers the record of a week previous (made by the "St. Louis") 1 hour 53 minutes and is a very creditable performance.

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Prolonged exposure of the person to the X-rays produces an effect on the skin similar to sun-burn. It also stops the growth of the finger nails and causes the hair to fall out. Mr. H. D. Hawks, who has done an unusually large amount of work with these rays, was compelled to suspend his experiments and seek medical treatment.

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The Boynton bicycle railroad, which is familiar to all who go to Coney Island by the Sea Beach route, and which was to revolutionize railroad construction, you know, has been sold under foreclosure proceedings to satisfy a claim of $2,810. The cost of the road was $30,000, and it brought $500, under the hammer.

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The "Practical Engineer," of London, sighs for the establishment by the British Government of a department for the dissemination of scientific information similar to that furnished by our own Smithsonian Institution and the National Museum.

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The "Worcester Daily Spy" distinguishes its 126th anniversary by the publication of a special "Industrial Edition," which contains "write-ups" of a lot of Worcester's industrial establishments, every one of which is loyally boomed as being the leader in its class. Even Worcester's hotels are praised! and nothing more need be said to illustrate the heroic work done by our ancient and honorable contemporary.

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Commercial Review.

NEW YORK, SATURDAY EVENING, AUGUST 15TH.

The Export Trade.

There are favorable signs in the export sky. Only recently the Baldwin Locomotive Works shipped sixty engines and fifty tenders to Russian railroads; and to equip an establishment to manufacture locomotives for herself, Russia came to the United States for the material. Now the railway supply trade with Japan seems in a fair way to prove a valuable thing. The Carnegie Company has just made a contract to furnish 9,000 tons of steel rails to that country, which follows an order for 10,000 tons which the Illinois Steel Company received a few months ago. The Carnegie Company's bid was enough lower than English prices to compensate for the greater cost of transportation. A commissioner of the Japanese Government is expected to arrive in this country next week, to make an investigation tentative to a change of the Japanese railroads from narrow-gage to broad-gage. It is reported that bids upon locomotives are being looked for in England and in this country. No rails are now made in Japan, but foundries are being built there by the Government, and powerful rolling mills are expected to be established in connection with them. The textile machinery used in that country comes principally from England and Germany, but it is said on good authority that if Americans can supply as high a quality they will find an excellent market for their wares.

An encouraging statement as to the outlook for American machinery in England is made by a gentleman representing a branch of that industry who has recently returned from a trip abroad. The field he considers a promising one, and machine shops there are busy, owing largely to the mining activity in South Africa, in spite of the embarrassments to which this has been subjected. He says that the bicycle business is good and that people are doing all they can to meet its requirements. The industry is on a healthful and well established basis; new concerns are not entering it, although some old ones are consolidating. He observes that the English are getting over their conservatism with regard to American tools, are taking more interest in them, and waking up to their merits. Although these have long been popular upon the Continent, the English have been slower to accept them, and at the time of a previous visit made by him two years since, appreciated them less than at present.

The trade with South Africa in mining machinery is another feature of exports which has awakened considerable interest. With two lines of steamers running directly from New York, and cheaper freights from here than from England, our manufacturers are afforded excellent facilities for competition with that country on her own private hunting ground. The fact that there is now some opposition to American machinery on account of its intrusion shows, as do also the export statistics, the foothold it has gained. To be sure, the troubles incident to Jameson's raid have lately been something of a handicap. The remark has been made to us by an official of a well-known company who manufacture a certain line of mining machinery, that the kind which is purchased in America is that which is not obtainable in England; and this suggests to us the idea that the ability of American tools to find a market abroad may be owing to something better than that our manufacturers have been reduced to as unprofitable a price footing as those of Europe.

The official summary of exports of machinery, including fire, locomotive and stationary engines, boilers, etc., from the United States for the month of June, 1896, shows a total of $1,560,946, as compared with $1,092,467 for June, 1895. For the twelve months ending June, 1896, they were $18,127,128, against $14,478,322 for the twelve months ending June, 1895. For the week ending August 15th we compute the outward manifests of machinery from this port to have amounted to $154,771. These weekly reports are based, in point of time, not upon the clearing of the vessels, but are made up from the reports of their cargoes as these are made public at the Custom House, often several days after sailing. Engines and boilers are, we believe, excluded from this latter classification.

Machinists' Supplies.

The features of these lines of business, represented by present experiences of local supply houses, point to the general domestic situation as being very quiet—perhaps even more so than it really is. The trade are now enjoying the combined effects of hot weather and hot politics, and the worst of the matter is that, with considerable harmony, they predict no relief from the present state of affairs before election time at the soonest. Probably they are best qualified to pass judgment upon the prospects of their own business, but our opinion would otherwise be, that, in the fall, shops, mills and factories should be settling down to work to a sufficient extent to create more of a demand for supplies than exists in vacation time.

Orders are of a hand-to-mouth character, and since manufactories are doing little work, even these sum up to but a small volume. Prices tend toward weakness and exceptionally difficult collections, now reported, do not tend to make the matter better.

The Boston Gear Works are sanguine as to the ultimate outlook. They say: "Business has been otherwise than brisk with us for the last four months. We, however, do not want to complain. We are confident that, after the election is over and the money question is settled, business in general will be better than ever. We are adding considerably to our stock of gears in anticipation of future orders. We believe that during the dull season is just the time to prepare for better times."

The Q. & C. Company, Chicago, manufacturers of railway specialties and special machinery, report that their large new works recently erected at Chicago Heights are kept quite busy on orders. Their metal sawing machine is in good demand, and there is no lack of business in their railway equipment and tie-plate department, the output of the latter of which alone will this year aggregate many millions.

Last week we commented at length upon the electrical machinery market. We may add the opinion of the Jenney Electric Motor Company, Indianapolis, Ind., that the inquiries for dynamos and motors

are not nearly as numerous as usual at this season of the year, apparently not more than half so, and they do not consider the outlook in this line of work very bright.

The Pratt Chuck Company, Clayville, N. Y., write us: "The results of the past year's business have been very satisfactory. The sale of our chucks showed a substantial increase over the previous year. The sale of our drawn work (ferrules, etc.), which is a new branch of our business, was up to expectations, and the outlook for the coming year is flattering. . . . We are pleased to say our foreign trade has been uniformly good the past year, and we have in hand a large order from the United States Government."

J. T. Slocomb & Co., Providence, R. I., manufacturers of small machinists' tools, say: "We are finding business in our line just now rather dull. We have been having more than we could handle up to a few weeks ago, but with the excessive heat we find a lull. We do not believe it is caused by anything more than heat, which causes people to lose interest in everything except keeping cool."

Power-transmitting machinery is re-

(Continued on page 39.)

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Help Wanted.

Situation and Help Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. The Cash and Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

TO SUBSCRIBERS

whose names appear on our **subscription** list, this paper will give two free insertions under this heading to those in want of positions. The advertisement to occupy a space of not more than five lines. Additional space or insertions must be paid for in advance at regular rates.

Wanted—Experienced draftsman wants position. Box 261, AMERICAN MACHINIST.

Wanted—Position to make details of machine tools. Box 262, AMERICAN MACHINIST.

Expert steam engineer wants position as chief of steam plant. Address Box 263, AMER. MACHINIST.

Comp. draftsman, grad. wants pos.; exp. in design'g eng's., boilers, gen. machy. E. P., AM. MACH.

Wanted—By the Nellis Belt Fastener Co., 284 Pearl street, New York, hustling salesmen on their patent fastener and pulley covering.

Designer and Draftsman wants pos., 12 years ex. on engines, tools and spec. machinery, capable in charge of work. Box 252, AM. MACHINIST.

Wanted—Mechanical draftsman, if possible with exp. in working sheet metals. Aps. with refs. and stating salary. Box 259, AMERICAN MACHINIST.

Mechanical draftsman and pattern maker wishes to correspond with parties requiring practical man to take charge of shop as supt. Box 260, AM. MACH.

Situation wanted by toolmaker (35) foreman, had charge of tool, model and experimenting work, with cycle manufacturing concern for the last 6 years. Box 254, AMERICAN MACHINIST.

Wanted—In a shop employing 250 men, head draftsman; one experienced in steam pump and compressed air work preferred; also a foreman for erecting department. Box 264, AMER. MACHINIST.

Foundry foreman, Amer., age 38, ex. and competent, would like to make change about Sept. 1st; engine or ma. work, green sand, dry sand or loam; understands chemistry of iron and mixing and melting of same; good ref. Address Box 255, AM. MACH.

Experienced mechanical engineer of Pittsburg, familiar with design and const'n of all iron and steel wks.' mach'y and having good acquaintance among the trade, wants to represent mach. shop or manfr. desirous of reach'g this sect'n. Box 257, AM. MACH.

Wanted—By an Eastern Canadian firm building slide valve Corliss engs. and general work, a thorough, competent foreman to take charge of lathe and planer work; about 30 men. Must be strictly temperate, up to date and a hustler. Address, stating wages required, Box 258, AMER. MACHINIST.

Wanted—Instructor in machine design and mechanics of machinery. Applicant to be a technical graduate of not less than three years' standing. Should give engineering and college record and references, minimum salary that will be acceptable and a list of two dozen machines that he is capable of designing. Work to begin September 23d and only a moderate salary to be expected. Address Prof. Mechanical Engineering, 357 Market Street, Bethlehem, Pa.

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Miscellaneous Wants.

Advertisements will be inserted under this head at 30 cents per line, each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Cheap 2d hd lathes & planers. S.M. York, Clev'd, O.

Calipers & Gauges. F. A. Welles, Milwaukee, Wis.

Best and cheapest Bolt Header, made by Baush & Harris Machine Tool Co.

Light and fine mach'y to order; models and electrical work specialty. E. O. Chase, Newark, N. J.

For Sale—Second-hand drill presses, engine lathes & planers. Dietz, Schumacher & Boye, Cincinnati, O.

For Sale—Part or all of a first-class plumbing and machine shop in a live city, Central Illinois. Ad-G. H., AMERICAN MACHINIST.

Wanted — A second-hand radial drill. State maker of same, condition, cash price. Middletown Machine Co., Middletown, Ohio.

Cheap for quick sale.—1 Wheeler Planer 42 x 42, very heavy, first-class condition; cost $1,900, will sell for $650. Butterworth & Lowe, Grand Rapids, Mich.

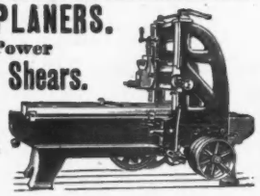
We offer an exceedingly fine lot of first-class second-hand machinery, lathes, planers, shapers, drills, millers, screw machines, etc. Call or get list 17 B. The Garvin Mach. Co., 440 Canal st., N. Y.

RUST ON BRIGHT METAL SURFACES ABSOLUTELY PREVENTED BY USING MANNOCITIN — USED BY LEADING FIRMS. WRITE FOR SAMPLE & PAMPHLET. OTTO GOETZE, 112 BROAD ST., N. Y.

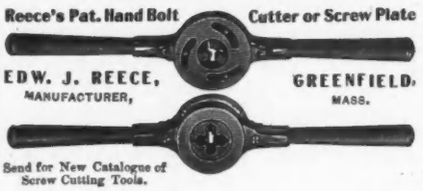
WIRE | THE WATERBURY MACHINE CO., Waterbury, Conn., Owners U. S. Patents Bolton Continuous Drawing Machinery. Modern machines for drawing all kinds and sizes of wire by multiple dies

POWER PRESSES, Punches and Shears, Reducing, Forming and Flaring Rolls, Power Hammers and Forging Machines. DIES AND SPECIAL MACHINERY. GODFREY J. BREMER MACHINE CO. Kalamazoo, Mich. Write for Catalogue "A" and Price-list.

WHITCOMB PLANERS. Hand and Power Punches and Shears. Whitcomb Mfg. Co. Worcester, Mass.



Reece's Pat. Hand Bolt Cutter or Screw Plate



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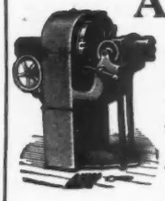
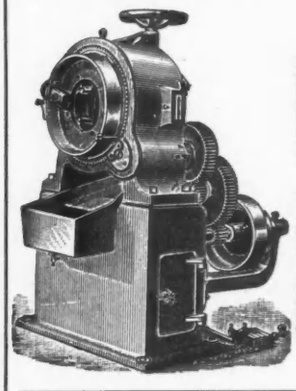
A VALUABLE BOOK NEARLY READY. Gas, Gasoline and Oil Engines By GARDINER D. HISCOX, M. E. 400 Pages. 200 Illustrations. Price, $2.50. This book treats comprehensively, and almost entirely of American makes of Gas, Gasoline and Oil Engines, with instructions for the care and management of the same. The author has probably had more experience with the manufacture, care and management of Engines of the above type than any other man connected with the subject. *ADVANCE ORDERS SOLICITED.* Send for our catalogues and special circulars of books for Machinists, Engineers, Electricians, and all practical trades. NORMAN W. HENLEY & CO., Publishers, 15 Beekman Street, New York.



ARMSTRONG'S Pipe Threading and Cutting-Off Machines Both Hand and Power. Sizes 1 to 6 inches. Water, Gas and Steam Fitters' Tools, Hinged Pipe Vises. SEND FOR CATALOGUE. THE ARMSTRONG MFG. CO. BRIDGEPORT, CONN.



CURTIS & CURTIS, 66 GARDEN ST., BRIDGEPORT, CONN. Pipe Cutting and Threading Machinery, FOR HAND OR POWER. RATCHET DRILLS, RATCHET DIE STOCKS AND MALLEABLE IRON PIPE VISES.

REPAIR BICYCLES FOR A LIVING. Fully illustrated. : : Treatise showing Tools and Shop Kinks mailed for 15 cents. : : : : FRED FRASSE, 17 Warren Street, *Near Broadway,* New York.

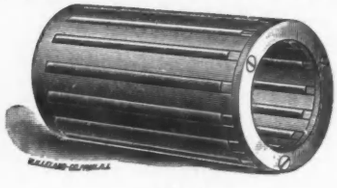
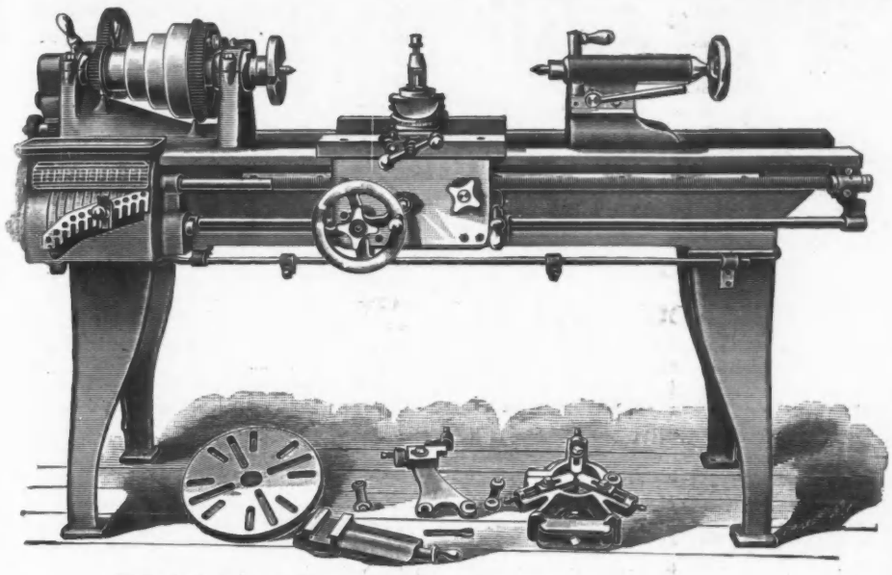


FIG. 2.

ROLLER BEARINGS. Wonderful results in durability and POWER SAVED. Rolling Mill Owners, increase the capacity of your mills by applying ROLLER BEARINGS. We are prepared to furnish Bearings for all sizes of Journals. Write for Stock List. Send six cents stamps for our 1896 Catalogue showing latest improvements in Rolling Mills, Automatic Drop Presses and Power Presses. MOSSBERG M'F'G CO., ATTLEBORO, MASS.



14 in. x 6 ft. Hendey-Norton Lathe with Improved Automatic Stop.

THIS Lathe COMBINES the LATEST and BEST Improvements. Automatic Stop. It is Simple, Durable, Indispensable. It will AUTOMATICALLY STOP the Carriage in EITHER direction. It is equally efficient whether FEEDING or THREAD-CUTTING. Running up to a shoulder, boring to BOTTOM of holes, or INTERNAL THREAD-CUTTING.

No danger of spoiling either tool or work. It is a safeguard against accidents, in either direction.

Feeds—It has all feeds in daily use with simple movement of lever.

Threads—It has all threads in daily use with simple movement of lever.

Carriage—The carriage reverses in Apron. No slamming of Countershaft. There is no comparison between this Lathe and the old style or common Lathe. Quick work, rapid changes, satisfactory results. BUY THE BEST.

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SCHUCHARDT & SCHUTTE,
59 Spandauerstrasse, Berlin.

SOLLER, Basel, Switzerland.

(Continued from page 38.)

ported much as we have described the general market; but one leading house finds that trade is holding its own fairly well for the season, and that the outfitting of new enterprises has not entirely ceased; and one dealer in tool and machinery steel and cold rolled shafting experiences a relatively good trade in the latter.

Iron and Other Metals.

The iron market still awaits a reawakening to activity. There are few signs of it as yet, although in some quarters there may be a trifle more feeling of general confidence.

The metals have acted during the week as though they were completely prostrated by the heat. Lead is at quotations which are said by a leading broker to be the lowest it has known in the history of the country; yet even this fact does not induce much buying. There is a great irregularity in the prices quoted upon spelter.

Quotations.

NEW YORK, Monday, August 17th.

Iron—American pig, tidewater delivery:

No. 1 foundry, Northern	$12 00 @ $13 00
No. 2 foundry, Northern	11 50 @ 12 00
No. 2 plain, Northern	10 50 @ 11 00
Gray Forge	10 50 @ 10 75
No. 1 foundry, Southern	10 75 @ 11 25
No. 2 foundry, Southern	10 25 @ 10 75
No. 3 foundry, Southern	10 00 @ 10 25
No. 1 soft, Southern	10 25 @ 10 50
No. 2 soft, Southern	10 15 @ 10 25
Foundry forge, Southern	9 75 @ 10 00

Bar Iron—Base—Mill price, in Carloads, on dock common, 1.10 @ 1.20c.; refined, 1.19 @ 1.35c. Store prices: common, 1.40 @ 1.50c.; refined, 1.50 @ 1.70c.

Tool Steel—Ordinary sizes, standard quality, 5¾ @ 7c.; extra grades, 11 @ 12c.; special grades, 16c. and upward.

Machinery Steel—From store, about 1.75. Special brands upward.

Cold Rolled Steel Shafting—Base size in carloads, about 2½c.; 2¾c. for smaller quantities from store.

Copper—Carload lots, Lake Superior ingot, 10¾ @ 11c.; electrolytic, 10¾ @ 10⅞c.; casting copper, 10⅜ @ 10⅝c.

Pig Tin—For 5 and 10-ton lots, 13 35 @ 13.45c. f. o. b.

Pig Lead—In carloads, 2 70 @ 2.75c.

Spelter—In carload lots New York delivery 3.75 @ 3.90c. for standard Western brands.

Antimony—Cookson's, 7 25c; Hallett's, 6.40c.; Japanese, 6.40c.

Lard Oil—Prime city, present make, 39 @ 40c.

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Manufactures.

Ground has been broken at South Haven, Mich., for a second new canning factory.

P. A. Field, of Beverley, Mass., is erecting a shoe factory, 42 x 100 feet at Salem, Mass.

On the Erie canal at Lockport, N. Y., new steel locks are to be erected, to be operated by compressed air.

The J. C. Hufinger Co., of Keokuk, Ia., will make some improvements in their already large plant. They use both steam and water power.

The M. S. Benedict Mfg. Co., of Syracuse, N. Y., will erect an addition to their works. This addition will be 50 x 120 feet and three stories high.

The Alabaster Mining Co., Alabaster, Mich., will shortly open a new mine. Engines, pumps, grinders, cars, hoisting machinery and conveyors will be installed.

The works of Dobbie, Stuart & Co., Niagara Falls, N. Y., were burned to the ground August 2d. They have decided to rebuild at once, and will place some new machinery.

The Munising R. R. Co., Munising, Mich., will

(Continued on page 40.)

(Continued from page 39.)

build and equip a railroad from St. Paul, Minn., to Munising, Mich. A repair shop will be erected and engines, pumps, tanks, etc., installed.

The Mewer Tool Co., 85 Exchange street, Portland, Me., have acquired from the Duff Construction Co. all rights in the drill which was illustrated and described in our issue of Dec. 26, 1895.

Since August 1st the main office of the Ball Bearing Co., has been moved to the factory 100 Norway street, Boston, Mass. Mr. H. A. Richmond has been elected treasurer in place of Mr. Ed. P. Noyes, resigned.

The Munising Lumber & Tannery Co., Munising, Mich., will erect plants for lumber and tanning manufacturing; cost $200,000. Engines, pumps, grinders, cars and improved saw mill machinery will be installed.

The Kalamazoo Heating, Lighting & Power Co., Kalamazoo, Mich., incorporated, capital $200,000, will erect and equip an extensive plant for the manufacture of gas and electricity for heating, lighting and power purposes.

Seine Manitou Gold Mining Co., Ltd., capital $500,000, are seeking incorporation, to operate a general mining b siness in the Province of Ontario, with head office at Toronto. S. H. Janes, W. H. Cawthra and Edmund Bristol are to be the first directors.

Under the Nova Scotia Act, incorporation of the New Egerton Gold Mining Company, Ltd., with a capital of $200,000, has been granted to James D. McGregor and Peter A. McGregor, of New Glasgow; John Yorston, of Pictou; George Mitchell, of Halifax, and John MacDougald, of Westville.

Paxton-Tate Co., Ltd., with a capital of $99,000, are seeking incorporation to manufacture saw mills, shingle machinery, turbine water wheels and a general foundry and machine business. First directors, Hon. John Dryden, Geo. Wm. Dryden and Wm. McGill, and chief place of business Port Perry, Ont., Canada.

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New Catalogs.

There are three sizes of Standard Catalogs, first authorized by the Master Car Builders' Association, 9" x 12", 6" x 9" and 3½" x 6". We recommend the 6" x 9" size for machinery catalogs. When they must be larger or smaller, one of the other standard sizes should be adopted if possible.

Builders Iron Foundry, Providence, R. I., send us a catalog of grinding and polishing machinery, with countershafts for the same, and of wood polishing machines. The catalog contains a great deal of interesting information on this class of work, and is standard size, 3½ x 6 inches.

J. F. Smith & Sons, Milwaukee, Wis., send us a catalog illustrating and describing bicycle hardware, which includes tubing, fittings, sprocket wheels, etc., used in the construction of bicycles. A number of fine illustrations are given, also a full explanation. The catalog is 8 x 11 inches.

The Watertown Steam Engine Co., Watertown, N. Y., have issued a new catalog of the Watertown engine. The catalog is exceptionally well printed and illustrated, and shows a variety of horizontal and vertical engines direct-connected to dynamos and otherwise. It is standard size, 6 x 9 inches.

The Savage Repeating Arms Co., Utica, N. Y., have sent us an illustrated descriptive catalog of the Savage repeating gun which was recently adopted for the use of the New York State troops. The catalog contains much interesting information regarding firearms, smokeless powder, etc., and is 5¼ x 9¼ inches, being possibly intended for standard size.

The Hamilton Machine Tool Co., Hamilton, O., have issued a new catalog which is devoted exclusively to the illustration and description of upright drill presses. These are made of various sizes and types, including those arranged in gangs for manufacturing purposes, and recent improvements are fully explained. It is 6 x 9¼ inches, and was probably intended to be standard size.

The Pratt & Whitney Co. HARTFORD, CONN., U.S.A.

... MAKERS OF ...

Fine Machine Tools.

Complete Plants furnished for Bicycle, Typewriter, Gun and Sewing Machine Makers. Gauges and Small Tools for all Machine Work. Drop Hammers and Trimming Presses. Forging and Trimming Dies for all classes of work.

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FINE MACHINE RELIEVED TAPS.

"Lightning" and "Green River" Screw Plates, Dies, Tap Wrenches, Bolt Cutters and Drilling Machines for Hand and Power, Punching Presses, etc.—SEND FOR CATALOGUE.

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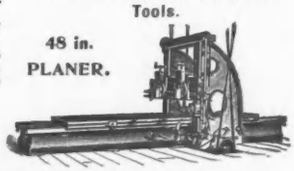

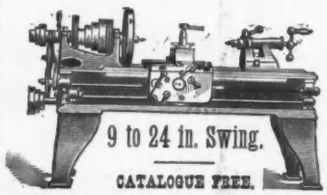

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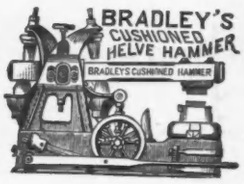

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